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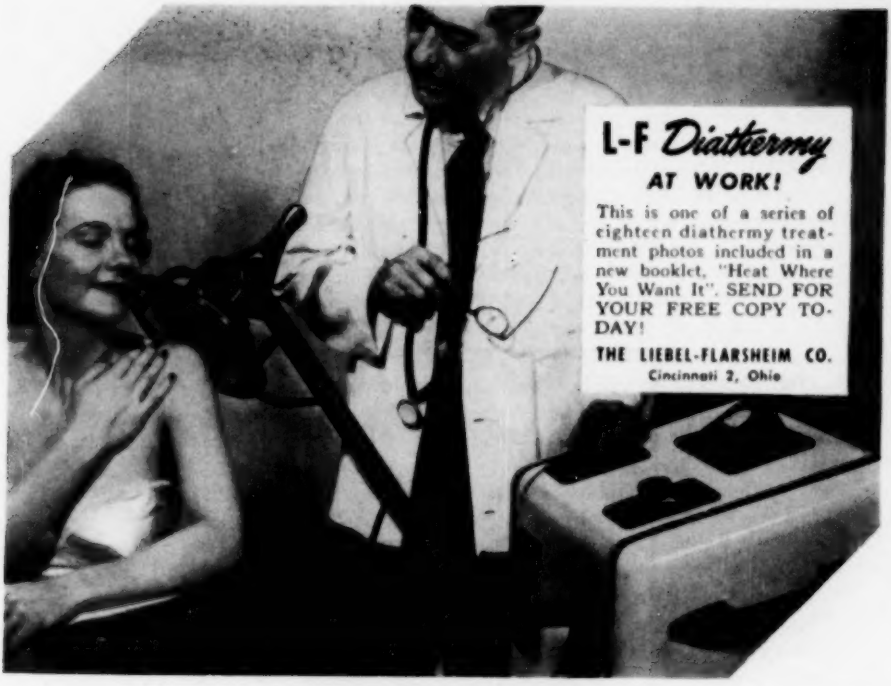

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John Stanley Coulter, M.D., 1885-1949

JOHN STANLEY COULTER
1885-1949

Dr. John Stanley Coulter, for many years treasurer and member of the editorial board of the American Congress of Physical Medicine, a past president of the Congress, member of the board and secretary of the American Registry of Physical Therapy Technicians, a past president of the American Society of Physical Medicine, chairman of the Council on Physical Medicine and Rehabilitation of the American Medical Association and a scientific adviser to the Baruch Committee on Physical Medicine and Rehabilitation, died at his home in Westville, Ind., Dec. 16, 1949, after a long illness.

Dr. Coulter was born in Philadelphia, Sept. 27, 1885. He received the doctor of medicine degree from the University of Pennsylvania in 1909 and was graduated from the Army Medical School in Washington, D. C., in 1911. During his service with the regular Army, he made a special study of tropical medicine at the University of the Philippines. He continued in the regular Army until 1920, when he came to Chicago to practice medicine. In 1926 he joined the faculty of Northwestern University Medical School with the rank of assistant professor of physical therapy; in 1932 he was advanced to the rank of associate professor, and in 1943 he became professor of physical medicine and head of the department. He was in charge of physical medicine departments at Illinois Central, Michael Reese, St. Lukes', Alexian Brothers, Passavant and Wesley Memorial hospitals in Chicago and was consultant in physical medicine at the Veterans Administration Hospital at Hines, Ill. He was also chairman of the subcommittee on physical therapy of the National Research Council, a charter member of the American Board of Physical Medicine and Rehabilitation, a member of the American Rheumatism Association and the Institute of Medicine of Chicago and a fellow of the American College of Surgeons. He also served on the advisory committee of the Parmly Foundation for Auditory Research. During World War I be was a lieutenant colonel in the medical corps of the United States Army and in World War II was regional medical officer of civilian defense for Illinois, Michigan and Wisconsin.

Through his writings and editorial services Dr. Coulter made valuable contributions to the advancement of medicine in general and physical medicine and rehabilitation in particular. In addition to his services as a member of the editorial board of the ARCHIVES he had written a history of physical medicine, was the author of several chapters in the "Handbook of Physical Medicine" and had contributed to Reimann's "Treatment in General Practice, Barr's "Modern Medical Therapy in General Practice" and Glasser's "Medical Physics." He was also one of the editors of "Principles and Practices of Physical Therapy." In recognition of the value of his contributions to medicine and his leadership in the field of Physical Medicine, the American Congress of Physical Medicine awarded him the gold key of merit.

With the passing of Dr. Coulter, the ARCHIVES has lost a devoted worker and an inspiring leader. Much of whatever merit it has is due to his efforts and his inspiration, and it will, it is hoped, continue to serve the cause of physical medicine, in which he was so deeply interested and which he so greatly enriched.

ULTRASONICS IN MEDICINE

PAUL A. NELSON, M.D.

Fellow in Physical Medicine, Mayo Foundation

J. F. HERRICK, Ph.D.

Division of Experimental Medicine, Mayo Foundation

and

FRANK H. KRUSEN, M.D.

Section on Physical Medicine, Mayo Clinic

ROCHESTER, MINN.

Ultrasonics as a separate science began little more than thirty years ago when Chilowsky and Langevin[1] made the first practical application of high frequency acoustic vibrations by developing a method of underwater communication. Since then several thousand articles on various applications of ultrasonics have appeared, written by scientists in many diverse fields.

Interest in ultrasonic radiation has increased markedly during the last few years among the following groups: physicists and chemists, who have studied and attempted to explain the propagation of ultrasonic waves and the phenomena involved; acoustical engineers, who claim the right of eminent domain in the subject; aeronautical engineers, who in the attainment of supersonic speeds with the jet plane have noted that ultrasonic vibrations are produced; geologists, who utilize ultrasonics in detection of oil and mineral deposits and in the study of seismic phenomena, and biologists and bacteriologists, who have been interested in the effect of ultrasonics upon living organisms. Many uses have been made of ultrasonics in industry, among which might be mentioned the following: measurement of thickness of pipes and detection of flaws in metal castings by such instruments as the Reflectogage and the Reflectoscope, respectively; aid in alloying metals, in obtaining fine emulsion in photographic film and in manufacturing chemicals with very small crystals; use as control apparatus, for example, door openers; testing of paints and varnishes and aging of liquors.

In contrast to the interest shown by other groups, members of the medical profession in this country have made little attempt to study the possible applications of ultrasonics in their own field. However, in Europe during the past ten years, particularly in Germany and Austria, a number of physicians have been utilizing ultrasonics for both diagnostic and therapeutic purposes in a wide variety of conditions. There are several reasons that the medical profession in the United States has taken this attitude: (1) Investigators in this country who pioneered in ultrasonics became discouraged concerning its clinical possibilities because of certain inherent technical difficulties, such as the measurement of intensity and the difficulty in obtaining reproducible data due to the variations of intensity in a given field; (2) suitable ultrasonic equipment was difficult to obtain until just recently, and (3) the average physician had no desire to use an unproved method of treatment upon his patients until sufficient experimental evidence had accumulated to show that such a trial was warranted.

In view of the considerable number of publications concerning ultrasonic therapy issuing from European clinics, it is somewhat surprising that so little has appeared in medical journals in this country. We have received

1. Chilowsky, C., and Langevin, P.: Procédés et appareils pour la production de signaux sous-marins dirigés et pour la localisation à distance d'obstacles sous-marins, Franz. Pat. Nr. 502913 (1916).

several requests for information and for references concerning various medical aspects of ultrasonics; in answering such requests we have had to refer to articles in foreign publications, which we realized were quite difficult to obtain. We have prepared this paper in the hope that it might serve a dual purpose: first, to acquaint the practicing physician with certain aspects of ultrasonics that are of importance to medicine and, second, to provide a useful bibliography for anyone who is contemplating further study or research in ultrasonics. This is not intended to be a comprehensive review of the literature concerning ultrasonics in medicine, but rather a brief summary referring to articles in this field which we have found especially interesting.

Historical Note

Although ultrasonics as a science is only thirty years old, interest in acoustic waves higher in pitch than the human ear can detect had been aroused considerably earlier. Galton,[2] for example, in 1883 designed a type of whistle that produced ultrasonic waves with a frequency of 25,000 cps. (cycles per second). In 1899 König[3] carried out a series of experiments with tuning forks only a few millimeters in length, which emitted ultrasonic vibrations. Probably the first investigator to set the upper limit of frequency for audible sound at its correct value of 20,000 cps. was Schulze,[4] in 1907. Despite the significant contributions of these men and others, it was the work of Langevin at the Toulon Arsenal from 1915 to 1917 that made possible the modern development of ultrasonics. Interesting accounts of his experiments can be found in a monograph by Wood,[5] who worked with Langevin, and also in an article by Klein.[6]

In the early 1920's relatively little research was carried out in ultrasonics; however, beginning in 1927 with a paper by Wood and Loomis,[7] numerous articles began to appear concerning various aspects of ultrasonics. During the next decade great progress was made in understanding basic physical and chemical phenomena caused by ultrasonics and their effect on certain organisms. In Germany, where many excellent investigations were carried out during this period, two texts appeared which are still the standard references in ultrasonics: one by Hiedemann[8a] in 1939 and the other by Bergmann[8b] in 1938. The latter has been translated into English.

Ultrasonic Apparatus

The most widely used method for producing ultrasonic vibrations is that which utilizes a piezoelectric crystal. Other types used less commonly are the Galton whistle, air siren, magnetostriction and the electromagnetic and

2. Galton, Francis: Hydrogen Whistles, Nature **27**:491 (Mar. 22) 1883.

3. König, Rudolph: Über die höchsten hörbaren und unhörbaren Töne von c^5 = 4096, Schwingungen (ut$_7$ = 8192vs), bis über f^9 (fis_{11}), zu 90000 Schwingungen (180000vs), nebst Bemerkungen über die Stosstöne ihrer Interwalle, und die durch sie erzeugten Kundt'schen Staubfiguren, Ann. Physics, **69**:626 (Nov.); 721 (Dec.) 1899.

4. Schulze, F. A.: Einige neue Methoden zur Bestimmung der Schwingungszahlen höchster hörbaren und unhörbaren Töne—Anwendung auf die Töne der Galtonpfeife und die Bestimmung der oberen Hörgrenze, Ann. Physics **24**:785, 1907.

5. Wood, R. W.: Supersonics: The Science of Inaudible Sounds. Providence, R. I., Brown University Press, 1939.

6. Klein, Elias: Some Background History of Ultrasonics, J. Acoustic Soc. America **30**:681 (Sept.) 1948.

7. Wood, R. W., and Loomis, A. L.: The Physical and Biological Effects of High Frequency Sound Waves of Great Intensity, Philosophic Mag. **4**:417 (Sept.) 1927.

8. (*a*) Hiedemann, Egon: Grundlagen und Ergebnisse der Ultraschallforschung, Berlin, W. de Gruyter & Co., 1939. (*b*) Bergmann, Ludwig: Ultrasonics and Their Scientific and Technical Applications (translated by H. S. Hatfield), New York, John Wiley & Sons, Inc., 1938. (*c*) Carlin, Benson: Ultrasonics, New York, McGraw-Hill Book Company, Inc., 1949. (*d*) Sollner, Karl: Sonic and Ultrasonic Waves in Colloid Chemistry, in Alexander, Jerome: Colloid Chemistry, Theoretical and Applied, New York, Reinhold Publishing Corporation, 1944, vol. 5, chap. 15, pt. 1, p. 227. (*e*) Allen, C. H., and Rudnick, I.: A Powerful High Frequency Siren, J. Acoustic Soc. America **19**:857 (Sept.) 1947.

9. (*a*) Smith, F. W., Jr., and Stumpf, P. K.: Ultrasonic Generator, Electronics **19**:116 (April) 1946. (*b*) Stumpf, P. K.; Green, D. E., and Smith, F. W., Jr.: Ultrasonic Disintegration as a Method of Extracting Bacterial Enzymes, J. Bact. **51**:487 (April) 1946.

gas current generators; satisfactory descriptions of these transducers are available elsewhere.[5]

A well known property of certain crystals, such as quartz, is their ability to become electrically charged on opposite surfaces when they are subjected to mechanical pressure. This property is called the piezoelectric effect. Because the reverse effect also occurs, such a crystal will undergo mechanical vibration when opposite sides are subjected to an alternating electric field. The amplitude of this vibration will be maximal when the crystal vibrates at its natural frequency, which is dependent upon its dimensions.

There is nothing particularly complicated about the construction of a piezoelectric transducer, which converts electrical oscillations into mechanical vibrations or the reverse. In certain types of apparatus a circular quartz disk is mounted between two metal rings, which serve as electrodes, and submerged in insulating oil. This oil provides a medium for transmission of ultrasonic vibrations from the crystal to the specimen and also serves as a means of insulating the high voltage electrodes and of carrying off some of the heat generated. An electrical oscillator generates the alternating electric field which is applied to the metal rings. In other types of transducers the quartz crystal may be cemented directly to the diaphragm of the applicator, or "sound head"; in this arrangement no oil is required. For further discussion of piezoelectric generators the reader is referred to the articles of Smith and his associates.[6]

The container housing the crystal can be adapted for various purposes, such as in vivo experimentation in which ultrasonics is applied directly to the animal, or in vitro, for the radiation of bacterial suspensions. In transducers designed for in vivo use, a coupling medium is required to transmit the vibrations from the diaphragm to the animal tissue. The coupling medium which we have found most convenient for our use is boiled water. In transducers which are designed for in vitro use over prolonged periods of radiation, the test tubes may be suspended directly in the oil. For such procedures, methods of cooling must be devised both for the suspension and for the oil.

Basic Physical Concepts

A sound wave in a fluid medium consists of a series of alternate compressions and rarefactions. If these vibrations have a frequency between 16 and up to about 20,000 cps. and an intensity between 0 and 120 decibels (that is, between 10^{-16} and 10^{-4} watts/cm.^{2}), they can be perceived as sound by the human ear.

An ultrasonic wave is entirely similar to a sound wave except that its frequency is greater than 20,000 cps. There is no fixed upper limit, but at the present time the highest ultrasonic frequencies obtained are about 1,000,000,000 cps. The wavelengths at this extreme approach those of visible light.

Unlike electromagnetic vibrations, of which light is an example, sonic and ultrasonic waves cannot pass through a vacuum but require some material medium for their propagation. They travel approximately four times as fast in liquids and up to twenty times as fast in solids as in air.

Because of their short wavelength, ultrasonic waves have some unique properties not observed in sound waves. They travel in straight lines, are completely reflected at the interface between two mediums if the critical angle is exceeded, exhibit interference phenomena and are refracted. Thus in some respects ultrasonic radiations may be said to have optical properties.

Tremendous forces are developed during the propagation of ultrasonic waves. With our apparatus a particle in the field is forced to vibrate through

800,000 cps., yet is not displaced from its position of rest by more than 0.00001 cm. Since the acceleration involved is actually of the order of 10^6 times that of gravity, it can be readily seen why this phenomenon has been described as "all acceleration and no motion."

Effects of Ultrasonic Radiation

An ultrasonic wave traveling through a liquid alternately compresses and pulls apart its component particles and thereby subjects the liquid to considerable strain. At a certain level of intensity the disruptive forces exceed the intermolecular bonds and the medium is actually split apart. The "cavities" produced in this manner are instantaneously collapsed by the force of atmospheric pressure and the succeeding compressive phase of the vibration. Tremendous energy is developed from the collapse of these cavities: it is this energy which is responsible for many of the important effects of ultrasonic radiation. The phenomenon which involves not only the formation of cavities but also their sudden collapse is called "cavitation." Cavitation does not occur in a medium receiving ultrasonics under conditions of increased hydrostatic pressure, in which case cavities cannot form, or of decreased pressure, where collapse of the cavities is not possible. For a more thorough discussion of this very important phenomenon the reader is referred to Sollner[8a] or Bergmann.[8b]

For convenience, the effects of ultrasonic radiation will be considered under the following headings: mechanical, thermal, chemical, biologic and physiologic. At the outset it should be mentioned that many of these effects are not limited to the ultrasonic range of acoustic vibrations but may be observed in the sonic range as well.[10] Because it is not possible to discuss these effects in any detail, references will be included to articles which we have found most helpful.

Mechanical Effects. — The mechanical effects of ultrasonic radiation can be conveniently divided into phenomena of dispersion and phenomena of aggregation. Sollner [8a] particularly has an excellent discussion concerning these effects, but the interested reader is referred also to Hiedemann[8a] and Bergmann.[8b]

1. Dispersion: a. Formation of Emulsions. Emulsions of immiscible liquids, such as oil and water or mercury and water, can be obtained by ultrasonics.

b. Formation of Fogs. Often during strong ultrasonic agitation a smokelike vapor or fog can be observed rising from the surface of the liquid.

c. Disintegration of Solids. Certain substances, such as sulfur or mica crystals, precipitates and even some colloidal particles, are broken up and dispersed when exposed to ultrasonics in a liquid medium.

2. Aggregation: a. Coagulation of Emulsions. If a colloidal solution of mercury and water prepared by ultrasonics is placed in another container and again exposed to ultrasonics, small droplets of mercury will soon settle to the bottom. This accumulative action of ultrasonics is termed "coagulation."

b. Coagulation of Smokes and Fogs. Air-borne ultrasonic waves can cause the instantaneous settling out of particles in smokes and fogs. In the future this method may prove to be a practical means of reducing smoke in large cities.

10. Chambers, L. A., and Gaines, Newton: Some Effects of Intense Audible Sound on Living Organisms and Cells, J. Cell. & Comp. Physiol. 1:451 (June) 1932. Flosdorf, E. W.; Chambers, L. A., and Malisoff, W. M.: Sonic Activation in Chemical Systems: Oxidations at Audible Frequencies, J. Am. Chem. Soc. 50:1049 (July) 1930.

c. Degassing. Expulsion of dissolved gases in a liquid occurs with ultrasonics, an effect that Boyle and co-workers[11] have studied in some detail.

d. Orientation. Certain solutions which contain dissolved oblong crystals will take on a shimmering appearance when exposed to ultrasonics; this is due to an orientation of the crystals with respect to the ultrasonic field.

Thermal Effects[12] — Considerable heating may occur in any medium exposed to ultrasonic radiation, depending upon the amount of energy absorbed. Dognon and Biancani[13] have shown that the degree of rise in temperature differs markedly from one liquid to another. In addition, several other factors influence the amount of heating that occurs in a medium, among which might be mentioned: 1. Reflection by interfaces: Ultrasonic energy is reflected by any discontinuity in the medium, such as dissolved gas bubbles, colloidal particles, precipitates and the walls of the container; this reflected energy is largely dissipated as heat. 2. Frequency of source: The higher the frequency of the ultrasonic vibrations, the greater the absorption of energy which may be converted into heat. 3. Cavitation: Considerable energy which is released when cavities collapse is transformed into heat.

In exposing bacterial suspensions to ultrasonic radiation, one must not allow the temperature of the specimen to rise above 30 C.; otherwise the bacteria will be killed by heat alone. Thus it can be seen that thermal effects, which are encountered in all work with ultrasonics, can often complicate problems in research.

Chemical Effects[14] — The separation of the phenomena that accompany ultrasonic radiation into mechanical, thermal and chemical effects is actually rather arbitrary, since they are interdependent. However, the following effects are generally considered to be chemical in nature:

1. Oxidation: The acceleration of oxidative reactions was noted by several of the early investigators[15] to accompany ultrasonic radiation. Schmitt, Johnson and Olson[16] were the first to show that this phenomenon was due to the presence of hydrogen peroxide which formed in water containing dissolved oxygen on exposure to ultrasonics.

2. Luminescence: Chambers[17] first reported the emission of light from certain liquids, such as glycerin and nitrobenzol, which were exposed to intense sonic radiation. Harvey[14a] later reviewed this subject most completely, pointing out that this phenomenon occurs with ultrasonic as well as with sonic vibrations.

3. Depolymerization: Ultrasonic energy can cause the breaking up of certain long chain polymers, such as resins, starches, rubbers and gums. This effect has made possible some interesting research with important theoretical implications concerning intermolecular and even intramolecular forces.[18] A possible application of this principle has been carried out in genetics, where Conger[19] has reported that a greater number of chromosomal aberrations occur when ultrasonics and roentgen rays are applied simultaneously than when

11. Boyle, R. W., Taylor, G. B., and Froman, D. K.: Cavitation in the Track of an Ultrasonic Beam, Tr. Roy. Soc. Canada s. 3, **23**:197, 1929.

12. Richards, W. T.: The Heating of Liquids by the Absorption of Sound, and Its Relation to the Energy of Intense High-Frequency Sound Waves, Proc. Nat. Acad. Sc. **17**:811, 1931. Bergmann,8b Sollner,8d

13. Dognon, A.; Biancani, E., and Biancani, H.: Ultra-sons et biologie, Paris, Gauthier Villars, 1927.

14. (a) Harvey, E. N.: Sonoluminescence and Sonic Chemiluminescence, J. Am. Chem. Soc. **61**:2392 (Sept.) 1939. (b) Bergmann, 8b. (c) Sollner, 8d.

15. Richards, W. T., and Loomis, A. L.: The Chemical Effects of High Frequency Sound Waves: I. Preliminary Survey, J. Am. Chem. Soc. **49**:3086 (Dec.) 1927. Wood and Loomis,7

16. Schmitt, F. O.; Johnson, C. H., and Olson, A. R.: Oxidations Promoted by Ultrasonic Radiations, J. Am. Chem. Soc. **51**:1274 (Feb.) 1929.

17. Chambers, L. A.: The Emission of Visible Light from Cavitated Liquids, J. Chem. Physics **3**:690 (May) 1937.

18. Mark, H.: Some Applications of Ultrasonics in High-Polymer Research, J. Acoustic Soc. America **16**:183 (Jan.) 1945.

19. Conger, A. D.: The Cytogenic Effect of Sonic Energy Applied Simultaneously with X Rays, Genetics **33**:607 (Nov.) 1948.

roentgen rays are applied alone. He expressed the belief that this is due to the mechanical vibrations which prevent the chromosomal fragments produced by the roentgen rays from reuniting and which increase the possibility of new reunions. However, the depolymerization effect of ultrasonics upon the long chain of nucleic acids must be considered in addition as a possible factor in the production of mutations. Newcomer and Wallace[20] recently have reported in a most interesting article that chromosomal and nuclear aberrations can be induced by ultrasonic vibrations alone. They also have noted stimulation of plant growth and earlier maturation of some plants following ultrasonic radiation, which supports the earlier work of Russian investigators (Isotomina and Ostrovsky.[21])

4. Discharge of Unstable Systems: Ultrasonics is able to detonate certain explosives, such as nitrogen triiodide, to cause superheated liquids to boil and to initiate crystallization in supersaturated solutions.

5. Miscellaneous: Various reactions occur upon ultrasonic irradiation which are not well understood, such as hydrolysis, changes in crystallization and inversion of cane sugar.

Biologic Effects. — When we consider the various changes just described that can be brought about by ultrasonics, it is not surprising that such vibrations can exert profound biologic effects. During Langevin's experiments it was noted that fish which swam into the ultrasonic beam were instantly killed. Wood and Loomis[7] published in 1927 the first report of biologic changes observed with ultrasonic radiation, such as laming and death of small fish and frogs, disruption of plant cells and protozoa and hemolysis of erythrocytes. Since then, many hundreds of articles have appeared dealing with the subject. It is not possible in this paper to do much more than mention just a few of the interesting experiments that have been carried out in this field. If the reader wishes to read further, there are several articles which have fairly extensive bibliographies.[22]

Harvey,[23] one of the first to observe the action of ultrasonics on living cells under a microscope, reported the following effects: whirling of protoplasm, displacement of small particles, stimulation of activity and finally disintegration of intracellular bodies and cytolysis. Further information was obtained by means of high speed photomicrography of fertilized eggs of Arbacia during exposure to ultrasonics (Harvey and Loomis[24]) and also of paramecia (Marinesco[25]). Schmitt and Uhlemeyer[26] ascribed the lethal effect of ultrasonic radiation on micro-organisms to cavitation, which in their opinion ruptured the cell membranes and thus accounted for the observed increase in cell permeability. In a recent article, Lepeschkin and Goldman[27] reported their study of the effect of ultrasonics on a number of types of cells and concluded that the changes noticed did not resemble those caused by heat but rather those produced by mechanical injury. They observed no difference in effects when they varied the frequency from 400,000 to 1,000,000 cps.

The bactericidal and virucidal effects of both ultrasonic and sonic radiations of high intensity have received a great deal of attention. The first re-

20. Newcomer, E. H., and Wallace, R. H.: Chromosomal and Nuclear Aberrations Induced by Ultrasonic Vibrations, Am. J. Botany **36**:220 (Feb.) 1949.
21. Isotomina, O., and Ostrovsky, E.: Quoted by Newcomer and Wallace.[20]
22. Gregg, E. C., Jr.: Ultrasonics: Biologic Effects, In Glasser, Otto: Medical Physics, Chicago, The Year Book Publishers, Inc., 1944, p. 1591. Footnote 8a, *b* and *d*.
23. Harvey, E. N.: Biological Aspects of Ultrasonic Waves: A General Survey, Biol. Bull. **59**:306 (Dec.) 1930.
24. Harvey, E. N., and Loomis, A. L.: High Speed Photomicrography of Living Cell Subjected to Supersonic Vibrations, J. Gen. Physiol. **12**:147 (Nov. 20) 1931.
25. Marinesco, N.: Quoted by Hiedemann.8a
26. Schmitt, Frances O., and Uhlemeyer, B.: The Mechanism of the Lethal Effects of Ultrasonic Radiation, Proc. Soc. Exper. Biol. & Med. **21**:626 (April) 1930.
27. Lepeschkin, W. W., and Goldman, D. E.: Changes in the Structure of Cells on Exposure to Ultrasound, Nav. M. Research Inst. Project, NM 004001, Report No. 3 (Jan. 6) 1949.

port of such effect was by Harvey and Loomis,[28] who described the destruction of luminous bacteria by ultrasonics. A comparison of ten species of bacteria with regard to their sensitivity to varying periods of ultrasonic radiation up to ninety minutes was carried out by Yen and Liu.[29] They clearly showed that some bacteria are more resistant to the action of ultrasonics than are others. Takahashi and Christianson[30] and Stanley[31] studied the virucidal effect of ultrasonic radiation on the tobacco mosaic virus. An excellent article has been published by Stumpf, Green and Smith[32] concerning practical suggestions about technic in radiation of bacteria. They have used ultrasonics as a means of analyzing bacteria with respect to enzymes, endotoxins, polysaccharides and other substances, which are very difficult to obtain by any other means. Rouyer and Grabar[33] have recently reported some interesting work concerning the mechanism of the lethal effect of ultrasonics on bacteria. The development of the method of exposing bacteria and viruses to intense sonic vibrations has paralleled the work with ultrasonics; as representative articles in this field one might mention papers by Williams and Gaines,[33] Chambers and Flosdorf,[34] Chambers and Weil[35] and Krueger, Brown and Scribner.[36]

Dognon and Biancani[12] demonstrated that certain organs in Daphnia could be paralyzed by ultrasonic radiation if a small intensity were used, that the sense of balance was damaged in tadpoles and in fish during radiation and that frogs able to withstand thirty minutes of exposure might have residual paralysis in the flexors of the legs.

One of the few studies concerning the heating effect of ultrasonics upon tissues was done by Freudlich, Söllner and Rogowski.[37] They concluded that bone marrow could be strongly heated by ultrasonic radiation and that such energy could be transmitted across a joint. They expressed the belief that the therapeutic possibilities in medicine as a form of diathermy merited further study.

Lynn and Putnam[38] were able to produce lesions of the brain in animals through the intact skull by focused ultrasonic radiation. Microscopic sections showed that first ganglion and then glial cells in the brain were most sensitive to ultrasonic radiation and that blood vessels were relatively little affected. The authors were unable to demonstrate any damage to the skull or meninges; however, in every animal gangrene of the scalp occurred at the site of application.

Frings, Allen and Rudnick[39] have carried out very interesting work with air-borne ultrasonic waves generated by a high frequency siren, producing vibrations with a frequency of 20,000 cps. and with an intensity of approximately 160 decibels. With exposures of one minute or less, they were able

28. Harvey, E. N., and Loomis, A. L.: The Destruction of Luminous Bacteria by High Frequency Sound Waves, J. Bact. 17:373 (May) 1929.
29. Yen, A. C. H., and Liu, S. C.: Effect of Supersonic Waves on Bacteria, Proc. Soc. Exper. Biol. & Med. 31:1260 (June) 1934.
30. Takahashi, W. N., and Christianson, R. J.: The Virucidal Action of High Frequency Sound Radiation, Science 79:415 (May 4) 1934.
31. Stanley, W. M.: The Action of High Frequency Sound Waves on Tobacco Mosaic Virus, Science 80:339 (Oct. 12) 1934.
32. Rouyer, M., and Grabar, P.: Étude du méchanisme de l'action des ultrasons sur les microbes, Ann. Inst. Pasteur 73:215 (March) 1947.
33. Williams, O. B., and Gaines, Newton: The Bactericidal Effects of High Frequency Sound Waves, J. Infect. Dis. 47:446, 1930.
34. Chambers, L. A., and Flosdorf, E. W.: Sonic Extraction of Labile Bacterial Constituents, Proc. Soc. Exper. Biol. & Med. 34:631 (June) 1936.
35. Chambers, L. A., and Weil, A. J.: Immunological Properties of Sonic Extract of Pneumococci, Proc. Soc. Exper. Biol. & Med. 38:924 (June) 1938.
36. Krueger, A. P.; Brown, B. B., and Scribner, E. J.: The Effect of Sonic Vibrations on Phage Precursor and the Bacterial Substrate, J. Gen. Physiol. 24:691 (July 20) 1941.
37. Freundlich, H.; Söllner, K., and Rogowski, F.: Einige biologische Wirkungen von Ultraschallwellen, Klin. Wchnschr. 11:1512 (Sept.) 1932.
38. Lynn, J. G., and Putnam, T. J.: Histology of Cerebral Lesions Produced by Focused Ultrasound, Am. J. Path. 20:637 (May) 1944.
39. Frings, Hubert; Allen, C. H., and Rudnick, Isadore: The Physical Effects of High Intensity Air-Borne Ultrasonic Waves on Animals, J. Cell. & Comp. Physiol. 31:329 (June) 1948.

to cause the death of certain insects, such as flies and mosquitoes, as well as of caterpillars and worms, and also of mice. They showed that heat alone produced through the absorption of ultrasonic energy could account for this effect. In addition, however, there were some evidences of rupture of tissues: for example, in destruction of wings of flies and of pinnae (ears) of mice.

Physiologic Effects. — The physiologic effects of acoustic vibrations are not well understood. These vibrations compose a wide spectrum extending from low frequency mechanical vibrations, as produced, for example, by a pneumatic hammer, through audible sound into the high frequency, ultrasonic range.[40] Ignorance of the exact physiologic effects on the part of the medical profession no doubt was the basis for persistent rumors during the war that personnel working near sources of intense sonic and ultrasonic energy were exposed to great danger. Finkle and Poppen[41] have made a definite contribution toward eventual understanding of problems in this field in their excellent study of the clinical effects of the turbo-jet engine on 9 Navy volunteers, who were exposed a total of twenty hours over a six week period. Of this group, 7 men complained throughout the experiment of increased fatigue and irritability and 5 lost from 5½ to 19 pounds (about 2.5 to 8.6 Kg.) in weight. In addition, a marked temporary loss in hearing occurred in all men, which was remedied later in the experiment by use of protective ear plugs and helmets. Otherwise, there were no positive findings, except for a slight fluctuation in the level of blood sugar. This article contains an interesting review of the literature and an excellent bibliography.

Many subjective reactions to exposures to ultrasonic waves have been reported. Wood[5] observed during Langevin's original experiments that he felt "an almost insupportable pain . . . which gave the impression that the bones were heated" when he held his hand near the transmitter under water. Persons working near the air siren of Frings, Allen and Rudnick[30] have noted a very similar sensation with air-borne ultrasonic waves; they have also experienced generalized fatigue, a peculiar tickling sensation in the mouth, dizziness and a "sense of impending doom."

Ultrasonics, as has been shown by German investigators,[42] can produce various changes in skin and superficial tissues, depending upon the dosage: hyperemia, edema and vesiculation. In the animals of Lynn and Putnam,[28] large doses produced gangrene; presumably this could also occur in human beings. Edema and "exudation" in the deeper tissues have also been described,[42] both of which might be explained on the basis of increased capillary permeability. The "exudation" referred to consists of the presence of erythrocytes and leukocytes in the tissues surrounding the blood vessels. Many European clinicians have spoken of the "analgesic" effect of ultrasonic radiation; it is not clear whether this can be ascribed to the secondary heating effect or whether it is supposed to be some unique effect of ultrasonics upon nerve tissue. Dittmar[43] has postulated that ultrasonics has an irritative effect upon superficial nerve fibers in the skin and also the nerve fibers in the blood vessels, in such a way as to cause local vasodilatation with moderate ultrasonic doses and local vasoconstriction with more intense doses. The whole problem needs much more research before an adequate understanding of

40. Davis, Hallowell: Vibrations and Its Physiological Effects, Biological and Psychological Effects of Ultrasonics, U. S. Navy M. News Letter (Aviation Supp.) 9:1 (July) 1948.
41. Finkle, A. L., and Poppen, J. R.: Clinical Effects of Noise and Mechanical Vibrations of a Turbo-Jet Engine on Man, J. Applied Physiol. 1:183 (Sept.) 1948.
42. Pohlman, R.; Richter, R., and Parow, E.: Ueber die Ausbreitung und Absorption des Ultraschalls im menschlichen Gewebe und seine therapeutische Wirkung an Ischias und Plexusneuralgie, Deutsche med. Wchnschr. 1:251 (Feb.) 1939.
43. Dittmar, Carl: Ueber die Wirkung von Ultraschallwellung auf tierische Tumoren, Strahlentherapie 78:217, 1948.

the basic physiologic phenomena accompanying ultrasonic radiation is reached.

Medical Aspects of Ultrasonics

Although ultrasonics had previously been used somewhat unsuccessfully in the treatment of loss of hearing, it was the work of Pohlman, Richter and Parow[42] in 1939 that first stimulated great interest in its therapeutic possibilities. They reported data on a series of 18 patients whom they had treated with ultrasonics: 9 with sciatica, 4 with neuralgia of the brachial plexus and 5 with arthritis. These patients were treated on the average about fifteen minutes daily. The treatments were carried out by moving the applicator slowly in a circular motion over the area of the lesion, for example, in sciatica over the proximal part of the sciatic nerve. As a means of obtaining good contact between the "massage head" (applicator) of the ultrasonic generator and the skin, bee venum salve was used. The authors stated that all patients with sciatica and neuralgia of the brachial plexus responded surprisingly well to treatment. Seven of the patients with sciatica required only four to nine treatments; the other 2 required eighteen and nineteen treatments. One patient with neuralgia of the brachial plexus was free of symptoms after one treatment of twenty-five minutes; the other 3 in this group were given three to seven treatments. Although they were treated even longer, no particular benefit was noted in the group of patients with arthritis.

Before carrying out any therapy, Pohlman, Richter and Parow[42] gave careful consideration to three basic questions: 1. At what intensity does damage to human tissue occur? In experiments on themselves the authors noted that the erythema which frequently followed ultrasonic radiation would recede with no apparent residual effect a few hours after treatment; an exposure of higher intensity would result in edema of the tissues and formation of blisters. Therefore, the intensity that produced definite erythema without edema was thought to be the correct dose for treatment. (In a later paper Pohlman[44] stated that this represented a value between 2 and 5 watts/cm.^{2} and that at an intensity between 3 and 4 watts/cm.^{2} a burning pain was noted by the patient.) 2. Is there latent or cumulative damage that occurs after many treatments, any one of which is insufficient to show immediate damage? In order to answer this question, Pohlman exposed the base of his thumb every day for eight weeks for five minutes at the foregoing intensity; no damaging effect whatever was noted. 3. What is the coefficient of absorption of ultrasonic energy in human tissue, or, in other words, how deep does this energy penetrate? Pohlman found that the absorption increased with the frequency of the ultrasonic vibrations. For example, at 2,400,000 cps. a layer of fat and muscle 1.5 cm. thick absorbs 50 per cent of the energy impinging upon its surface; at 800,000 cps., however, a layer 4.9 cm. thick is required to absorb half of the energy. For this reason, and also because frequencies lower than 500,000 cps. are extremely uncomfortable, Pohlman selected 800,000 cps. as the frequency most satisfactory for therapy.

Relatively few papers were published during the war concerning the therapeutic use of ultrasonics. In 1940 Florstedt and Pohlman[45] reported that skin became more permeable to histamine, apitoxin and cantharidin during ultrasonic radiation. Scholtz[46] in 1942 confirmed Pohlman, Richter and

44. Pohlman, Reiner: Die Ultraschalltherapie: Quantitative Angaben zu ihrem Wirkungsmechanismus, Deutsche med. Wchnschr. 23:373 (Sept.) 1943.
45. Florstedt, H., and Pohlman, R.: Ueber die perentane Applikation von Medikamenten durch Ultraschall, Ztschr. f. d. ges. exper. Med. 107:212 (Jan.) 1940.
46. Scholtz, H. G.: Ultraschall zur Behandlung von Emphysem und Asthma, Deutsche med. Wchnschr. 68:490 (Sept.) 1942.

Parow's[47] work in the treatment of sciatica and reported good results in asthma and chronic emphysema treated with ultrasonics. With a technic similar to that of Pohlman and co-workers, he carried out five to ten minutes of treatment on each side of the sternum and also on each side of the thoracic portion of the spinal column. He stated that patients felt subjective warmth and prickling sensations during treatment; a short time later they found it easier to breathe and were able to cough up considerable mucus. Since this work, several other writers have claimed similar and supposedly beneficial results in the treatment of asthma.[47] The rationale of such treatment is not clear, and controlled studies on many cases will be necessary before its true effectiveness can be determined.

Within the past few years many articles have appeared in European journals reporting excellent response to ultrasonic therapy in a vast number of diseases; a list could be compiled that would include such diverse conditions as elephantiasis, osteoporosis, anal fissure, mammary carcinoma, laryngeal catarrh, vesical spasm, metrorrhagia and bed wetting. At the recent Ultrasonics Congress at Erlangen, a survey was made of patients who had responded well to ultrasonics at forty clinics; statistics were assembled which indicated the clinical impressions of physicians concerning results in the treatment of about thirty-six diseases or conditions. The following are typical of those listed: (1) "Inflammatory" — abscess, lymphadenitis, adnexitis, mastitis, prostatitis, periarthritis, arthritis, endarteritis obliterans and tuberculous fistulas and adenitis; (2) "Deformative" — Dupuytren's contracture, cicatricial contractions and rheumatoid spondylitis; (3) "Dermatologic" — eczema, ulcers, scleroderma and warts; (4) "Rheumatic and Neurologic" — sciatica, lumbago, myalgia and neuralgia, and (5) "Special" — otosclerosis, asthma, diphtheria carriers and sinusitis. In any one of the foregoing conditions, with two exceptions, the response of patients to treatment with ultrasonics showed according to this survey 50 per cent or more received either "marked improvement" or "complete cure." There has been little evidence of any critical or truly scientific evaluation of ultrasonic therapy in this wide variety of diseases.

There appears to be a considerable amount of disagreement in European literature as to whether or not various diseases of the ear are benefited by ultrasonic radiation. Of all the conditions surveyed at Erlangen, otosclerosis is the only one which no one claimed could be completely "cured" or markedly improved by ultrasonics. Buchtala[48] has stated that treatment of deafness with ultrasonic radiation of low frequency and small intensity, as originally advocated by Voss[49] and Hamm,[50] had so little to offer that very few physicians were now using this method. Denier[51] apparently no longer believes that otosclerosis can be helped by ultrasonics. Nevertheless, Wyt[52] and Wiethe[53] have claimed excellent results in the treatment with ultrasonics of various conditions of the ear. Wyt, using a very high frequency (500,000,000

47. (a) Henkel, K.: Meine Erfahrungen mit Ultraschall zur Behandlung von Neuritis und Asthma, Strahlentherapie **77**:291, 1948. (b) Anstett, P.: Soixante cas d'asthme traités par les ultrasons, Lyon méd. **179**:429 (June 27) 1948.

48. Buchtala, Viktor: Ultraschalltherapie: Anwendungsberich und Kontraindikationen, Aerztl. Wchnschr. **3**:321 (June 15) 1948.

49. Voss, O.: Ultraschallwellen im Dienste der Behandlung chronischer Schwerhörigkeit, Arch. f. Ohren-, Nasen-u. Kehlkopfh. **135**:258 (July 14) 1933.

50. Hamm: Eine neue Behandlungsweise chronischer Schwerhörigkeit, mit hochfrequenten Schallstrahlen, Klin. Wchnschr. **37**:1723 (Sept.) 1930.

51. (a) Denier, A.: L'ultra-sonothérapie en 1948, Acta physiother. rheumat. belg. **3**:236 (Sept.-Oct.) 1948; (b) Denier, André: Les ultra-sons. Leurs applications au diagnostic; ultrasonoscopie et à la thérapeutique: ultra-sonothérapie, J. de radiol. et d'électrol. **27**:481 (June 25) 1946.

52. Wyt, L.: Die Ultraschallbehandlung von Ohrgeräuschen, Wien. med. Wchnschr. **98**:405 (Sept. 25) 1948.

53. Wiethe, Camillo: Klinische Erfahrungen mit Ultraschall, Wien. klin. Wchnschr. **61**:17 (Jan. 14) 1949.

cps.), applied ultrasonics to a series of 18 patients, all of whom had tinnitus as a prominent symptom. The conditions had been diagnosed variously as otosclerosis, "deafness due to old age," "inner ear degeneration," "arachnoiditis of the base of the brain," traumatic deafness and adhesive otitis media. Of this group, Wyt claimed that 88 per cent obtained improvement with regard to the tinnitus and that 2 became completely free of this symptom. Of the 16 patients who had had difficulty in hearing, Wyt claimed that 68 per cent showed improvement while the rest were uninfluenced. He made the interesting observation that frequently with the treatments patients would complain of slight dizziness, nystagmus or increased salivation; he considered that these were desirable symptoms since they seemed to indicate that ultrasonics were affecting the inner ear. Wyt admitted that although his results were encouraging it was yet too soon to make a final evaluation of this therapy.

Hintzelmann[54] has treated a rather large series of patients who had rheumatoid spondylitis and is convinced that there is definite improvement following ultrasonic radiation. In this article he claimed to have effected a decrease in the amount of pain and stiffness and to have increased mobility in all directions and also to have increased chest expansion and vital capacity. Buchtala[55] subsequently supported these claims of Hintzelmann.

Not much of value can be gained by consideration of additional diseases which have been said to be benefited by treatment with ultrasonics. Many of the articles in this field merely list certain diseases and the number of patients that the authors have treated and then state that response to therapy has been excellent. It is apparent that in such reports the clinical investigations were not done according to the usual scientific methods.

Only a very few articles have mentioned contraindications for ultrasonic radiation. Apparently a few have been stumbled upon by accident. Henkel[47a] mentioned 2 patients he encountered who had received treatment elsewhere: the first was a patient with cardiac disease who went into severe shock following an ultrasonic treatment in which the applicator had been held over the precordium for a prolonged period; the second was a patient who, while receiving radiation over the eye, sustained a severe retinal hemorrhage and detachment. Buchtala[55] stated that ultrasonics should not be applied to (1) growing bone, particularly near the epiphyses, since there is some evidence that ultrasonics causes early ossification; (2) the gravid uterus; (3) the reproductive glands; (4) the region of the cervical ganglions in patients with cardiac disease, and (5) the extremities in Buerger's disease.

Ultrasonics in Treatment of Malignant Tumors. — Because ultrasonic treatment of malignant tumors has received considerable attention in the past few years, it is necessary that this subject be discussed in some detail. Before Horvath began publishing his articles, several investigators had reported experiments in which tumors in animals had been exposed to ultrasonic radiation. The first of these were a number of Japanese workers[56] who in 1934 and 1938 published brief reports containing some rather inconclusive results concerning effects of radiation on tumors in mice, rats and chickens. Beck

54. Hintzelmann, U.: Ultraschalltherapie rheumatischer Erkrankungen, Deutsche med. Wchnschr. 73:250 (July 6) 1947.

55. Buchtala, Viktor: Die Ultraschallwirkung auf den wachsenden Knochen: Ergebnisse tierexperimenteller Untersuchungen an jungen Hunden, Strahlentherapie 78:127, 1948.

56. Nakahara, W., and Kobayashi, R.: Biological Effect of Short Exposure to Supersonic Waves. Local Effect on Skin, Jap. J. Exper. Med. 12:137, 1934. Hayashi, S.: Einflüsse der Ultraschallwellen auf das Wachstum des Rüttensarkoms, Jap. J. M. Sc., III. Biophysics 5:162 (April) 1938. Hirohashi, K., and Hayashi, S.: Einflüsse der Ultraschallwellen auf den Rattenkarzinomtumor, ibid. 5:162 (April) 1938. Namikawa, K.: Einflüsse der Ultraschallwellen auf die Entwicklung des Hühnersarkoms, ibid. 5:162 (April) 1938.

and Krantz[57] in 1940, working with Walker sarcoma 319 in rats, were able to report a slight inhibition of growth of the tumors and a small increase in glycolysis within the tumors following treatment with ultrasonics. In 1942 Auler and Woite[58] observed in vitro destruction of carcinoma cells obtained from ascitic fluid in mice, which was proportional to the dilution of the specimen and the amount of exposure to ultrasonics.

Horvath[59] published in 1944 his first report of treatment by ultrasonics of a generalized reticulum cell sarcoma with cutaneous metastatic growths. After surprisingly good results in treatment of one of these tumors he irradiated several others, noting the macroscopic and microscopic changes, the optimal intensity and duration of treatment and the most effective method of application. Using a bland ointment as a contact medium, he applied the "massage head" gently to the tumor and moved it about slowly in a circular motion for fifteen to twenty minutes. He decided that the optimal intensity for treatment was that which subjectively produced a stinging yet bearable pain. Shortly after treatment he noted hyperemia and vesiculation in the epidermis overlying the tumor; occasionally with longer exposures, edema and petechiae appeared. After twenty-four hours the surface of the tumor became slightly wrinkled and discolored because of the gradual disappearance of edema and drying of vesicles. After ten days the tumor presented a characteristic, "sunken" appearance, and after five to six weeks it had disappeared.

Dyroff and Horvath[60] studied the microscopic changes following ultrasonic radiation and reported that after twenty-four hours fading of the malignant cells and clumping of chromatin could be seen; that after forty-eight hours numerous vacuoles appeared in the cytoplasm; that after three days the malignant cells were so broken up they presented a "histologic field of ruins," and by the eleventh day had completely disappeared. In general, the histologic picture did not resemble that seen following burns, roentgen rays or radium treatments; rather, it appeared to be similar to that found following mechanical trauma.

In a subsequent article Horvath[61] reviewed 3 cases in which he had treated cutaneous malignant lesions on the face. In another article[62] he described a new method of administering ultrasonics through a water tube, the advantages of which lay chiefly in obtaining more even distribution of energy and a more hygenic method of treatment. In his most recent article[63] he asserted that any failures in treatment were due to poor technic; yet he mentioned that in 1 case "x-ray ulcer and carcinoma" had recurred. He also claimed that he had very good results in the treatment of cutaneous and mammary carcinoma with combined ultrasonic and roentgen ray therapy.

Within the past year some articles have appeared which caution against the use of ultrasonics in the treatment of maligant lesions. Buchtala,[49] for example, stated that he believed that more harm than good could occur if the local physician attempted to treat such tumors with ultrasonic radiation.

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57. Beck, Frances F., and Krantz, J. C., Jr.: Glycolysis in Tumor Tissue: III. The Effect of Ultrasonic Vibrations on the Growth and Glycolysis of Walker Sarcoma 319, Am. J. Cancer 39:245 (June) 1940.
58. Auler, Hans, and Woite, Hubert: Ueber die Einwirkung von Ultraschallwellen auf die Krebszellen des Mäuseascites, Ztschr. f. Krebsforsch. 53:90 (Oct.) 1942.
59. Horvath, J.: Ultraschallwirkung beim menschlichen Sarkom: I. Klinischer Teil, Strahlentherapie 75:119, 1944.
60. Dyroff, R. V., and Horvath, J.: Ultraschallwirkung beim menschlichen Sarkom. II. Histologischer Teil. Strahlentherapie 75:126, 1944.
61. Horvath, J.: Ueber die Wirkung der Ultraschallwellen auf den menschliche Karzinom, Klinik u. Praxis 1:10 (Feb. 6) 1946.
62. Horvath, J.: Weitere Erfahrungen über die Wirkung der Ultraschallwellen auf das menschliche Karzinom, Klinik u. Praxis 1:108 (May) 1946.
63. Horvath, J.: Experimentelle Untersuchungen und therapeutische Erfahrungen mit Ultraschallwellen, Aerztl. Forsch. 3: Jan. 10, 1949.

He said that one cannot speak of good clinical results in such treatment; even if the tumor did regress in size, it was likely that there would not be complete destruction of cells. It is significant that the Ultrasonics Congress at Erlangen in May 1949 refused to endorse the treatment of carcinoma with ultrasonics.

Also published within the past year is an extremely interesting article by Dittmar,[61] who studied the effects of ultrasonics on two types of malignant tumors in rats and rabbits: the fast-growing Walker carcinoma, which never undergoes spontaneous involution, and the slower-growing Jensen sarcoma, which undergoes frequent spontaneous involutions. He was able to show that these tumors behaved entirely differently in response to ultrasonic radiation; on one hand, the Jensen sarcoma could be completely destroyed through intensive radiation; while on the other hand, the Walker carcinoma survived even longer radiation. Dittmar stressed the importance of the temperature at which radiation is carried out. By controlling the temperature of the water which served as a coupling medium, he was able to observe that much greater damage occurred when radiation was carried out above 37 C. than below this temperature. At no time in his experiments did the temperature exceed 50 C., a temperature which normal tissue can withstand in vitro for hours without damage but which is injurious to the more sensitive malignant tissue. Dittmar believed that an important aspect of the effect of ultrasonics lay in its effect on blood vessels which supply the tumor. Besides this, he thought it possible that there might be direct thermal damage of the tumor cells. He pointed out that the effect of ultrasonics upon Jensen sarcoma closely resembled that which Horvath obtained in his experiments with relatively benign cutaneous tumors. It would appear that this work of Dittmar is important enough to merit further study.

Ultrasonics as an Aid in Diagnosis. — In 1942 Dussik[64] recommended that ultrasonics be utilized as an aid in medical diagnosis. The device that he recommended for this purpose operates on the same principle as does the Reflectoscope,[65] which sends pulsed ultrasonic waves into a metal block and picks up their reflections from the opposite surface or from any irregularities that lie in their path. It is possible that any marked difference in tissue density could cause alterations in the conduction and reflection of the ultrasonic waves much as does a flaw in a metal casting. Dussik[66] and Denier[51b] have claimed that this instrument has special value in locating brain tumors and areas of scar tissue or encephalomalacia and in the outlining of abdominal viscera and tumors.

Recently in this country Ludwig and Struthers[67] have reported some excellent work concerning the utilization of ultrasonics in detecting gallstones and foreign bodies in vivo in animal tissue. They concluded that the optimal range in frequency for such procedures lies between 1.0 and 2.5 megacycles, where sufficient tissue penetration and adequate resolving power is obtained for detection of average sized gallstones.

Conclusions

On the basis of existing experimental evidence there is not enough known concerning the physiologic effects of ultrasonics to recommend its use in

61. Dussik, K. T.: Ueber die Möglichkeit, hochfrequenzig mechanische Schwingungen als diagnostisches Hilfsmittel zu verwerten, Ztschr. f. d. ges. Neurol. u. Psychiat. **174**:153 (April) 1942.

63. Firestone, F. A.: The Supersonic Reflectoscope, an Instrument for Inspecting the Interior of Solid Parts by Means of Sound Waves. J. Acoustic Soc. America. **17**:287 (Jan.) 1946.

66. Dussik, K. T.: Zum heutigen Stand der medizinischen Ultraschallforschung. Wein. med. Wchnschr. **81**:248 (April 23) 1949.

67. Ludwig, G. D., and Struthers, F. W.: Considerations Underlying the Use of Ultrasound to Detect Gallstones and Foreign Bodies in Tissue, Nav. M. Research Inst. Project, NM001001, Report No. 1 (June 15) 1949.

the treatment of any human disease. It is inadvisable to use ultrasonics in the treatment of those conditions in which there are other proved methods of treatment and in which delay in instituting surgical, roentgen ray or radium therapy might well prove fatal for the patient. The reports which have been published so far present, for the most part, only clinical impressions and no truly scientific controlled analyses of the effects of ultrasonic therapy.

On the positive side, it seems evident that there is a great opportunity for fundamental research in ultrasonics in the medical laboratory. The medical diagnostic and therapeutic possibilities of ultrasonics merit more careful scientific evaluation than has yet been accorded them. We have inaugurated laboratory studies which we hope will contribute to the general understanding of the medical aspects of ultrasonics and will lead us eventually to decide whether or not this interesting new physical agent can be recommended for diagnosis or for therapy.

THE RELATIONSHIP BETWEEN DEEP TISSUE TEMPERATURE AND BLOOD FLOW DURING ELECTROMAGNETIC IRRADIATION *

ALFRED W. RICHARDSON, Ph.D.
CHARLES J. IMIG, R.P.T., M.S.
BARBARA L. FEUCHT, R.P.T., M.S.
and
HARRY M. HINES, Ph.D.
IOWA CITY

Controversy exists concerning the relative effectiveness of various thermogenic electromagnetic wave generators for augmenting blood flow in peripheral structures. The ability of short wave diathermy to increase the temperature of tissues has been common clinical knowledge. Krusen, Herrick, Leden and Wakim[1] demonstrated that microwaves also effectively heated the highly vascularized musculature of the dog. Kemp and coworkers[2] reported that, while blood flow in the femoral artery of the dog was increased by microwave irradiation, treatments with short wave diathermy were often accompanied with either unchanged or decreased blood flow (table 3). Later Siems, Kosman and Osborne[3] confirmed the findings of these investigators as to the effects of microwaves but reported an increase in blood flow by the use of short wave diathermy as well (table 3). They suggested that these different wavelengths were equally effective in increasing blood flow in the hind extremity of the dog. Wakim and co-

* From the Department of Physiology, College of Medicine, State University of Iowa.

* Read at the Twenty-Seventh Annual Session of the American Congress of Physical Medicine, Cincinnati, Sept. 10, 1948.

1. Krusen, F. H.; Herrick, J. F.; Leden, U., and Wakim, K. G.: Preliminary Report of Experimental Studies of the Heating of Microwaves, Proc. Staff Meet., Mayo Clin. 15:194, 1947.

2. Kemp, C. R.; Paul, W. D., and Hines, H. M.: Studies Concerning the Effect of Deep Tissue Heat upon Blood Flow, Arch. Phys. Med. 29:12, 1948.

3. Siems, L. L.; Kosman, A. J., and Osborne, S. L.: A Comparative Study of Short Wave and Microwave Diathermy on Blood Flow, Arch. Phys. Med. 29:759, 1948.

workers[4] found that diathermy caused an increase in the blood flow in the hindlimb of anesthetized dogs in 13 of the 17 experiments and a decrease in 4 of the experiments (table 3). Flax, Miller and Horvath[5] noted four types of response in peripheral blood flow following local application of diathermy in human subjects: no vasodilation in the distal area; gradual vasoconstriction; marked vasodilation, and no change in blood flow. In view of these findings it was considered of interest to investigate further into the role of these thermogenic agents in causing changes in tissue temperature and blood flow.

Method

A 16 meter short wave generator and a 12.25 cm. microwave generator were used during these experimental studies. The microwave generator was capable of delivering a peak output of 125 watts, but outputs of 25 watts and 63 watts were used in these experiments. A rectangular corner type wave director was used because it was found by test to be more efficient and less variable in output. Care was taken that no large metal objects obstructed the field. The short wave generator was tuned to obtain as nearly constant output as possible. Temperatures were taken by means of iron-constantan thermocouples housed in hypodermic needles as described by Tuttle and Janney.[6] Potentials were recorded on a Leeds and Northrup type 8662 potentiometer, and temperature measurements were calibrated with a Bureau of Standards thermometer. In the microwave series, temperatures were taken in the gastrocnemius muscle of the dogs at a 1 cm. depth before, during and after exposure. In the short wave series, temperatures were taken at the same position and depth before and after exposure. It was found by test that the short wave field affected the thermocouple reading while the microwave field did not measurably affect the thermocouple reading at these power outputs employed. Careful tests were made in air, water and tissue to establish this fact. For added care, the last measurement in each exposed series was made just subsequent to the cessation of irradiations in order to continuously confirm this observation.

Blood flow measurements were made by means of an electromagnetic flowmeter of a direct cannulation type as described by Richardson, Randall and Hines.[7] This meter permitted a reliable continuous record of flow during the observations. All flow measurements were made in the femoral artery of dogs which were anesthetized prior to experimentation with an intravenous injection of 37 mg. of pentobarbital sodium per kilogram of body weight. In all experiments control flow measurements were taken for fifteen to thirty minutes before heating was initiated. For short wave diathermy study, control and experimental measurements were made before and after irradiation on 13 normal dogs, which were arbitrarily divided into three groups in order to test the effect of three independent variables upon blood flow. The animals of the first group were heated by means of a pancake coil over the gastrocnemius muscle and separated from the overlying skin by a 1 inch pad. This group received a near maximum output of the short wave generator for fifteen minutes. The second group of animals were heated by an induction coil circumscribed in a spiral about the leg and were exposed to a near maximum output of the short wave generator for thirty minutes. The animals of the third group were selected from the lots as those having the highest rates of initial control flow. The method of heating was otherwise similar to the first group. For the microwave study, control and experimental measurements were made on 15 normal mongrel dogs which were divided into two groups, one of which received 25 watts' irradiation and the other 63 watts' irradiation. Both were exposed for fifteen minutes, with the wave director at a 5 cm. distance from a point over the gastrocnemius muscle.

Results

In the study employing short wave diathermy, when the hindlimbs of dogs were irradiated for fifteen minutes with a pancake coil as a heating

4. Wakim, K. G.; Gersten, J. W.; Herrick, J. F.; Elkins, E. C.; Krusen, F. H., and Porter, A. N.: The Effects of Diathermy on the Flow of Blood in the Extremities, Arch. Phys. Med. **29**:582, 1948.
5. Flax, H. J.; Miller, R. N., and Horvath, S. M.: Alterations in Peripheral Circulation and Tissue Temperature Following Local Application of Short Wave Diathermy, Arch. Phys. Med. **30**:630 (October) 1949.
6. Tuttle, W. W., and Janney, C. D.: The Construction, Calibration and Use of Thermocouples for Measuring Body Temperatures, Arch. Phys. Med. **29**:418, 1948.
7. Richardson, A. W.; Randall, J., and Hines, H. M.: A Newly Developed Electromagnetic Blood Flow Meter, J. Lab. & Clin. Med. **34**:1766, 1949.

unit, there was no significant increase in blood flow in the femoral artery. This is revealed upon an examination of table 1. It may be seen that although

TABLE 1. — *Average Temperature and Blood Flow Changes Due to Short Wave Diathermy Irradiations.*

Time, Min.	Pancake Coil, 15 Min. Irradiation		Induction Coil, 30 Min. Irradiation		High Initial Flow, 15 Min. Irradiation	
	Temp., °C.	Blood Flow, Cc./Min.	Temp., °C.	Blood Flow, Cc./Min.	Temp., °C.	Blood Flow, Cc./Min.
Preheating control periods						
1	37.3	62	37.0	43	36.6	100
5	37.3	66	37.0	45	36.6	99
10	37.3	60	37.0	42	36.6	94
15	37.3	64	37.0	43	36.6	89
Postirradiation periods						
1	40.1	....	41.8	....	39.5	80
5	.....	66	39.9	61	.....	72
10	.....	60	40.7	59	.....	71
15	37.8	61	39.9	64	.....	68

the blood flow in the femoral artery was not increased, the temperature of the gastrocnemius muscle at 1 cm. depth increased from 37.3 to 40.1 C., resulting in a mean rise of 2.8 degrees. Since the characteristics of the short wave field would not allow the use of a thermocouple during heating, the exact temperatures during heating were not known. The latter figure cited represents the temperature thirty to sixty seconds following irradiation.

When the hindlimbs of dogs were irradiated for thirty minutes by means of an induction coil surrounding the leg, a 42 per cent increase in blood flow was measured in the femoral artery following heating. This increase was found significant at the 1 per cent level. Under these conditions the temperature in the gastrocnemius muscle was increased from 37.0 to 41.8 C.

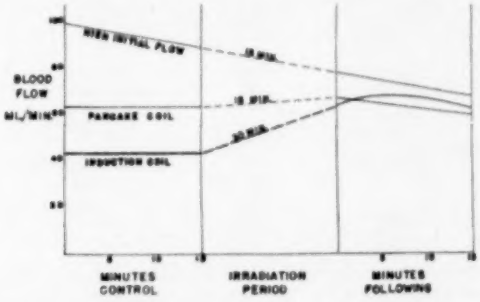

Chart 1. — The results of short wave diathermy upon blood flow in the femoral artery of the dog under three experimental conditions.

Again, since the characteristics of the short wave field would not permit the use of a thermocouple during heating, one can only speculate as to the maximum temperature which prevailed during heating.

A third group of animals in this study were selected for possessing a high initial rate of flow, whereas otherwise the experimental conditions were similar to the first group, i. e., the limbs were irradiated for fifteen minutes with a pancake coil over the gastrocnemius muscle. As shown in chart 1 which delineates the results in these three groups, the average blood flow appears to drop with time when the animals possess a relatively high initial flow. This apparent difference was not found significant, the critical ratio

being established at 0.71, but it is comprehensible how studies made under high initial flow conditions might well display a tendency toward a flow decrease during and after irradiation if the tissue temperature increases were of a low magnitude. Also, it is a reasonable hypothesis that this flow decrease, if found, may represent a decline due to factors other than irradiation.

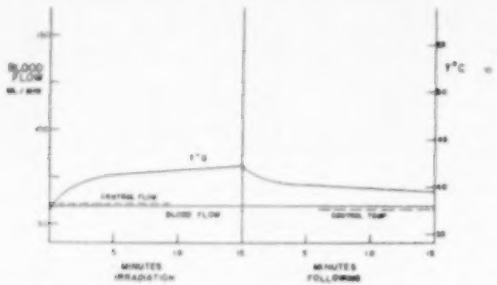

Chart 2. — The result of microwave irradiation upon blood flow in the femoral artery of the dog when 25 watt power output was used. The rise in temperature was insufficient for increased flow.

The blood flow studies on these 13 dogs would seem to indicate that short wave diathermy irradiations of a large magnitude increase blood flow in the periphery, while irradiations of a small magnitude do not significantly

TABLE 2. — *Average Temperature and Blood Flow Changes Due to Irradiations with 12.25 Cm. Microwaves for Fifteen Minutes.*

Time, Min.	25 Watts		63 Watts	
	Temp., °C.	Blood Flow, Cc./Min.	Temp., °C.	Blood Flow, Cc./Min.
During control period				
1	37.8	64	37.6	59
5	37.8	62	37.6	61
10	37.8	57	37.6	60
15	37.8	59	37.6	60
During irradiation period				
1	38.3	60	38.8	60
5	41.1	61	44.5	72
10	41.5	59	46.6	88
15	42.1	60	43.8	111

affect the flow of blood. With this view in mind, the microwave study was set up to evaluate more closely the role of induced temperature upon the flow of blood.

When the hindlimbs of 7 dogs were irradiated by means of 12.25 cm. microwaves using 25 watts power, there was no significant change in blood flow in the femoral artery. The results are shown in table 2 and in chart 2. It may be observed from these data that, although the blood flow in the femoral artery was not increased by the irradiations, the temperature of the gastrocnemius muscle at 1 cm. depth increased from 37.8 to 42.1 C. within the fifteen minutes of exposure, resulting in a mean temperature increase of 4.3 degrees. The measurements of temperature and blood flow were continued for fifteen minutes following irradiation with the intent of observing whether there was any latent increase in blood flow due to the temperature changes. No such latent effect was found.

One is inclined to speculate from the results on this series of animals that a critical threshold temperature may exist above which the rate of blood flow is increased. If present, it probably would be in excess of 42.1 C. Although the animals exposed to short wave diathermy had evidenced an increase of blood flow at a lower temperature than this, the temperature measurements were made a short time following the irradiations so that a temperature fall very likely preceded the measurements.

When another series of eight animals were irradiated by 12.25 cm. microwaves employing 63 watts output, it was found that there was no increase in blood flow until the temperature in the gastrocnemius muscle at 1 cm. depth reached a level of from 43 to 44C., whereupon the rate of blood flow began to increase. This augmentation of flow was continued to the end of the fifteen minute irradiation period, at which point it had reached an 85 per cent increase over control level. The increase in the rate of flow continued after the irradiation, but less rapidly, for ten minutes whereupon it declined steadily to reach control level again in from twenty-five to thirty minutes. At its peak, the rate of volume flow was increased 100 per cent over the control level, significant at the 1 per cent level of confidence. These results can be seen in table 2 and chart 3, where it is revealed that the aver-

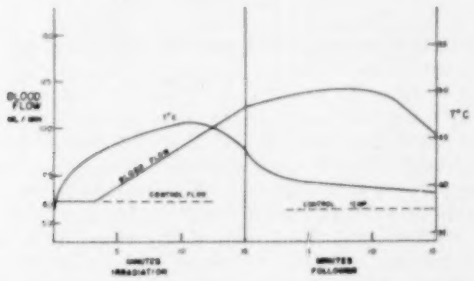

Chart 3. — The result of microwave irradiations upon blood flow in the femoral artery of the dog when 63 watt power output was used, showing the increased flow initiated at a critical threshold temperature.

age volume flow rate increased from 60 cc. per minute to 120 cc. per minute as a result of the irradiations. In these studies, no implication is intended which would correlate the depth of 1 cm. with any physiologic mechanism. This depth was selected as convenient for a constancy of measurement, with the realization that it repfesented only one point on an induced temperature gradient. It may be seen in chart 3 that after ten minutes' irradiation by microwaves under these conditions the temperature ceased to increase and progressively declined to the end of the exposure.

Comment

These studies may help in some small measure to clarify the picture where workers, on one hand, find no increase in blood flow or even, in some cases, a decrease in flow as a result of irradiations by one thermogenic agent, while, on the other hand, other workers report an increase in flow with this or other thermogenic agents. These inconsistencies may be due in some cases to variations in the vascular condition of the animals or the type of flowmeters used, but it is more likely that the magnitude of heating plays a

more significant role in the blood flow problem than formerly supposed. These studies suggest that there is a critical threshold temperature above which

TABLE 3. — *Effects of Electromagnetic Irradiations upon Blood Flow in the Extremities of Anesthetized Dogs.*

Author	Wavelength	Final Temp. °C.	Temp. Changes °C.	Effect on Blood Flow
Kemp, Paul & Hines[2]	Short wave	39.80	+2.7	No change or decrease
	Microwave	42.4	+4.3	Increased
Siems, Kosman & Osborne[3]	Short wave	41.5	+3.6	Increased*
	Microwave	43.6	+5.2	Increased
Wakim and others[4]	Diathermy	41.8	+4.0	Increase in 13 out of 17 cases Decrease in 4 out of 17 cases
Present study	Pancake short wave	40.1	+2.8	No change
Present study	High control flow			Decreased
Present study	Short wave induction coil	41.8	+4.8	Increased
Present study	Microwave 25 watts	42.1	+4.3	No change
Present study	Microwave 63 watts	47.0	+10.0	Increased

* 5 per cent level of confidence.

an acceleration of blood flow in an extremity is initiated. Induced temperatures of a lower magnitude apparently have no significant effect upon blood flow. The variation in this threshold temperature was not found to be great, the range falling between 42 and 44 C. at 1 cm. depth (table 3).

There was no exception found for the phenomenon of a critical threshold temperature for blood flow increase where continuous records were made. It appears unfortunate that a continuous record would not be made in a short wave diathermy field. Although the standardization of the site of temperature measurement contributed to the establishment of threshold temperature, it offers little in the clarification of the exact site of the mechanism which instigates the flow increase. This may involve local temperature increases in superficial tissues, deep tissues or both and at times a general rise in body temperature. One must proceed with caution in stating a critical threshold temperature under any conditions unless that statement is accompanied with an indication of designated depth because obviously the induced temperature at other depths may be different.

The results as a whole indicate that the effects of treatments with short wave diathermy and with microwaves upon blood flow depend not upon the specific effects of any wavelength but upon the degree of induced tissue hyperthermia. If degrees of deep tissue hyperthermia comparable to those found in animal experiments are required to produce increases in blood flow in human subjects, it would appear as if the therapeutic dosages most frequently employed would be insufficient to induce appreciable changes in the blood flow in deep tissues.

Summary

1. Irradiation of peripheral tissues by short wave diathermy may or may not increase the flow of blood in the area, depending upon the degree of tissue hyperthermia.

2. Irradiation of peripheral tissues by 12 cm. microwaves may or may not increase the flow of blood in the area. This also depends upon the magnitude of tissue heating.

3. It was necessary to increase the tissue temperature of an extremity of the dog, at 1 cm. depth, to a level of from 42 to 44 C. in order to increase consistently the flow of blood in the femoral artery, when 12 cm. microwaves were employed.

4. When the flow of blood was sufficiently increased by continuous irradiation, the temperature ceased to rise and eventually was diminished when the rate of flow was great enough, so that the peak temperature often preceded the termination of irradiation. The increases in blood flow persisted for as long as thirty minutes following irradiation.

THE INFLUENCE OF NATURALLY CARBONATED MINERAL WATER ON GASTRIC MOTILITY AND THE SECRETION OF HYDROCHLORIC ACID*

F. A. HELLEBRANDT, M.D.

and

SARA JANE HOUTZ, M.S.

With the Technical Assistance of Ellen Neall Duvall, Ph.D.

RICHMOND, VA.

The naturally carbonated waters of Saratoga Springs were known to the Mohawk Indians for many years before the coming of the white man. History records that the first white man to take the waters was carried to the springs by friendly Indians in 1767.[1] According to legend, his rehabilitation was so complete that he was able to walk back to Schenectady, a distance of approximately 40 miles. The first medical account of the waters was written by Dr. Samuel Tenny, a regimental surgeon who visited the springs during the American Revolution at the time of the Battle of Saratoga. The earliest experimental studies were conducted by Mitchell shortly thereafter. Thus the general characteristics of the mineral waters of Saratoga Springs have been known for more than 150 years. Describing them Tenny wrote as follows:

> Their taste is (apparently) acido saline, and much the same in all of the springs mentioned. Though the taste itself is not pleasant, yet the impression which the water makes on the organs of taste, as it passes over them, is very lively, pungent, and agreeable; like that of good bottled beer or cider; and after drinking freely of them, I usually had eructations of the same pungent, stimulating gas, as is produced by drinking those liquors. Unpleasant as their taste is at first, habit not only renders them tolerable; but to most persons very agreeable. Most of the invalids whom I sent to the waters, drank them after a short time with great avidity, to the amount of several gallons in a day. . . .

In about 1910 the State of New York began to acquire the springs of the Saratoga region and gradually improved the facilities required for their therapeutic application. In the first ten years of their recent operation as a part

* From the Division of Clinical Research, Baruch Center of Physical Medicine and Rehabilitation, Medical College of Virginia.

* Read at the Twenty-Seventh Annual Session of the American Congress of Physical Medicine, Cincinnati, Sept. 9, 1949.

1. Sigerist, H. E.: The Early Medical History of Saratoga Springs, Bull. Hist. Med. 13:540, 1943.

of the State's Public Health Policy, a million and a quarter treatments were given to 125,000 patients.[2] Of these, approximately 18 per cent had chief complaints referable to the gastrointestinal tract and presumably came to Saratoga Springs to drink the waters. The empirical evidence accumulated during this period by McClellan and his associates suggests that the ingestion of these naturally carbonated saline, saline-alkaline or alkaline-saline waters is indicated in the treatment of functional derangements of the intestine, stomach, liver and gallbladder.[3] As far as we have been able to determine, the acute effects of such procedures have never been subjected to systematic study, nor have investigations been instituted for the purpose of differentiating the influence of the spa regimen from that attributable to the ingestion of the waters per se. The study herein reported was designed to meet both of these objectives. Its purpose was to observe the influence of naturally carbonated saline-alkaline and alkaline-saline mineral waters on the secretory and motor behavior of the normal stomach.

Methods

The subjects of the investigation were 8 normal healthy adults, 2 men and 6 women. The majority of the observations were made on 2 subjects well trained in the technic of tube swallowing and accustomed to the restrictions associated with serving as subjects for human research. In toto 126 experiments were performed, 39 at the Saratoga Spa, 76 at the Medical College of Virginia and 12 at Charles University in Prague. During the Saratoga studies, test waters were ingested daily in doses used clinically for a period equivalent to the average course of treatment. Thus both acute and cumulative effects could be observed.

1. *Secretory Studies.* — Standard procedures were followed. The majority of the observations were made in the postabsorptive state, fourteen hours after the last meal. Some were instituted two to three hours following the normal evacuation of a light breakfast or approximately 250 cc. of unsweetened black coffee. After the Rehfuss tube had been swallowed, salivary secretion was prevented from contaminating the gastric contents by expectorating saliva as rapidly as it accumulated or by continuous suction. When the contents of the fasting stomach had been aspirated, control or experimental procedures were introduced. Controls were of three different types: first, observation of the spontaneous secretion of the fasting stomach; second, response to stimulation by the secretagogue histamine (0.1 cc. of 1:1,000 histamine acid phosphate per 10 Kg. of body weight, administered subcutaneously), or third, the influence of the oral ingestion of 500 to 1,000 cc. of a noncarbonated, lightly mineralized spring water of known composition (Saratoga State Seal). In the first two types of control observations the total contents of the stomach were aspirated at ten minute intervals; in the third, the contents of the stomach were thoroughly mixed by repetitive suction and reinjection of the material aspirated before withdrawing a sample for purposes of titration. Free and total acidity were determined by titrating with tenth-normal sodium hydroxide using dimethylaminoazobenzene and phenolphthalein, respectively, as indicators.

The subjects remained quietly in the laboratory during all observations. These lasted from sixty to one hundred and sixty minutes. During this time the subjects were protected from such stresses as are known to affect gastric function. When observations were prolonged over a period of many months, histamine controls were introduced periodically. Thirty-one such tests were performed. Fourteen observations were made with the noncarbonated control water, and 68 basal samples were withdrawn from the fasting stomach for the purpose of studying the range and incidence of spontaneous variations in acidity.

The bulk of the experimental observations, 18 and 29, respectively, were made after the ingestion of a naturally carbonated alkaline-saline (Saratoga Geyser) or saline-alkaline (Saratoga Coesa) water. Ten were made with various Czechoslovakian mineral waters similar in composition. The majority of the experimental waters were administered in a single dose of 500 cc. The remainder were given in twice the volume. They were ingested either in a single dose or in 100 cc. portions every ten minutes. They were taken cold (approximately 45 F.) and were swallowed as rapidly as possible.

2. McClellan, W. S.: New Trends in the Treatment of Chronic Disease: An Experience in Spa Therapy, Pub. of Saratoga Spa, No. 13, Saratoga Springs Authority, Saratoga Springs, N. Y., 1944.
3. McClellan, W. S.: Indications for the Internal Use of the Naturally Carbonated Mineral Waters of the Saratoga Spa, Pub. of Saratoga Spa, No. 9, Saratoga Springs Authority, Saratoga Springs, N. Y., 1939.

The drinking period for single doses never exceeded ten minutes and was usually considerably shorter. Epigastric discomfort and eructation were the exception. The only evidence of distention was a transitory period of shallow and rapid breathing secondary to pressure of the ingested fluid and gas upward on the diaphragm. Exaggerated borborygmus was commoner, especially following the ingestion of large doses of carbonated saline-alkaline water.

2. *Motility Studies.* — Seven pilot experiments were performed for the study of gastric motor behavior, using a balloon of condom rubber attached to a Marey tambour through a bromoform manometer. Changes in intralumen pressure were recorded on the drum of a slowly moving kymograph. The effects of a commonly used carbonated beverage and 500 to 1,000 cc. of naturally carbonated alkaline-saline or saline-alkaline water were observed. These pilot experiments were followed by 21 intubation studies using a Miller-Abbott double-lumen tube. This permitted the simultaneous observation of gastric secretory and motor behavior. During the double intubation studies the subject assumed a semirecumbent position which could be maintained without discomfort for three or four consecutive hours. In this series of observations, the influence of 500 cc. of naturally carbonated saline-alkaline water was compared with spontaneous variations in secretion and motility or the influence of 500 cc. of the noncarbonated, lightly mineralized control water.

The degree of mineralization of the domestic saline-alkaline and alkaline-saline waters studied is 12.91 and 7.28 Gm. per liter, respectively. Thus they are classifiable as moderately strong.[4] Underground, these waters are impregnated with 2 to 4 volumes of carbon dioxide gas. All the waters used had been freshly bottled. The following are the chief mineral constituents (mg. per liter) of the two waters on which most of the observations were made, reported as is customary in terms of their hypothetic combination.

	Alkaline-Saline (*Geyser*)	Saline-Alkaline (*Coeur*)
Ammonium chloride	48.25	45.25
Lithium chloride	21.07	20.52
Potassium chloride	361.91	307.27
Sodium chloride	2010.48	6370.30
Potassium bromide	9.23	2.00
Potassium iodide	1.10	1.60
Sodium sulphate	None	None
Magnesium sulphate	None	None
Sodium metaborate	Trace	Trace
Sodium nitrate	Trace	Trace
Sodium nitrite	Trace	Trace
Sodium bicarbonate	2213.78	1617.08
Calcium bicarbonate	1829.14	2819.86
Barium bicarbonate	16.67	34.93
Strontium bicarbonate	Trace	Trace
Ferrous bicarbonate	9.94	19.59
Magnesium bicarbonate	735.89	1650.54
Alumina	7.14	10.79
Silica	19.40	13.20
Total solids	7284.00	12912.93

Results and Their Interpretation

Residence at the spa and work in a laboratory abroad had all the psychosomatic concomitants usually associated with a change in scene. However, control observations (the secretory response to a standard dose of histamine) remained essentially unaltered. Nor were cumulative effects demonstrable when test waters were ingested daily for a period of one month. Although the methods used are admittedly crude, there is ample clinical evidence to indicate that, when carefully studied, the general pattern of the response of the stomach to a constant stimulus is repeatable within limits sufficient not to jeopardize the validity of deductions based on secretory data.[5] This view is supported by the evidence presented in chart 1. Wide variations

4. Fitch, W. E.: Mineral Waters of the United States and American Spas, Philadelphia, Lea & Febiger, 1927.

5. Bockus, H. L.: Gastro-Enterology, Vol. I, Philadelphia, W. B. Saunders Company, 1944. Bloomfield, A. L., and Keefer, C. S.: Clinical Physiology of the Stomach. Simultaneous Quantitative Observations on Gastric Secretory Volume, Acidity and Motility, Arch. Int. Med. 38:145, 1926.

in acidity do not occur when factors known to affect the titer of the juices withdrawn are carefully controlled. The normal stomach responds similarly

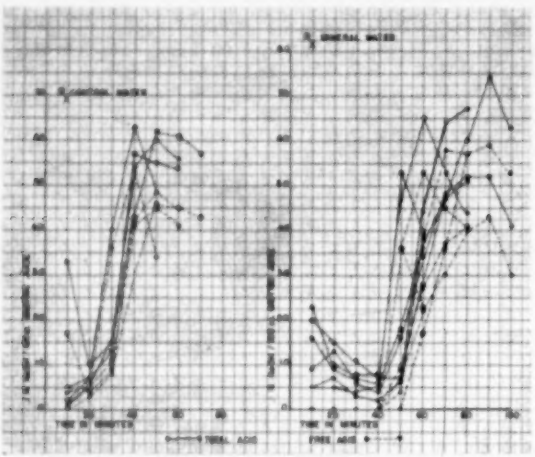

Chart 1. — The constancy of the secretory response of a well trained normal subject to the repeated administration of equivalent volumes of a control and a naturally carbonated saline-alkaline mineral water.

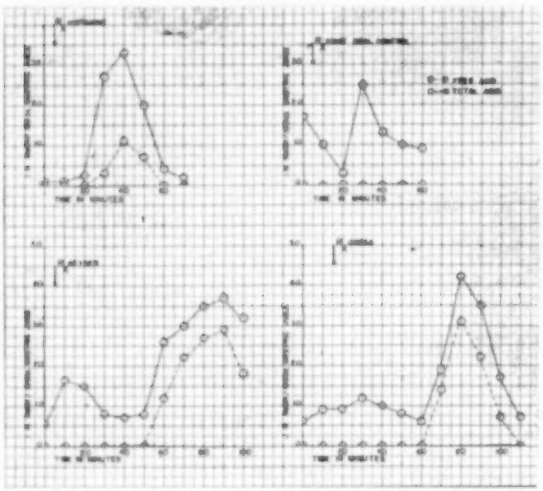

Chart 2. — The subject of these experiments had an asymptomatic hypochlorhydria. Naturally carbonated mineral waters had a greater effect on secretory activity than histamine given in the usual clinical dosage.

to a given stimulus from day to day, and this is especially true if the subject is well trained.

1. *Secretory Studies.* — The average value of the residual juice aspirated from the fasting stomach at the onset of the experimental period was 13.24 and 23.2 clinical units (cubic centimeters of tenth-normal sodium hydroxide to neutralize the hydrochloric acid in 100 cc. gastric juice) for free and total acidity, respectively. This varied insignificantly from the mean acidity of

the basal juice secreted spontaneously by the unstimulated stomach (12.44 and 20.06). Intraindividual variations were great, acidity fluctuating cyclicly in relation to spontaneous changes in motility.[6] In general, the ingestion of the noncarbonated, lightly mineralized control water had a mildly stimulating effect on secretion. The average free hydrochloric acid rose to 37 with a total acidity of 49. The ingestion of an equal volume of carbonated alkaline-saline water increased the secretion of free hydrochloric acid by 17.22 per cent above that of the control water, and total acidity by 7.68 per cent. The

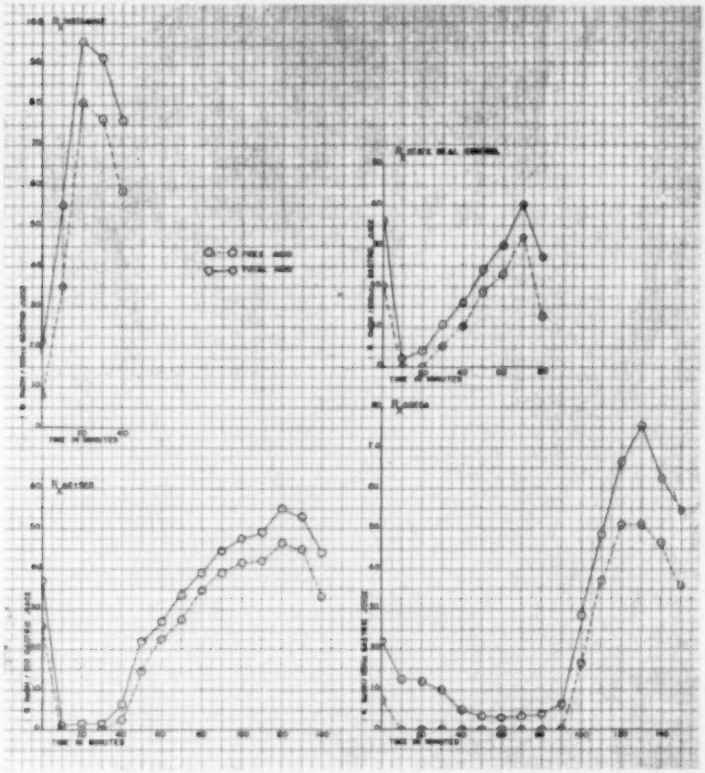

Chart 2. — The subject of these experiments demonstrated an average normal secretory response to histamine but had a slowly emptying stomach.

more highly mineralized carbonated saline-alkaline water had a somewhat greater effect. The augmentation in free and total acidity averaged 28.72 and 19.77 per cent, respectively. Sample records from 3 different subjects are illustrated in charts 2, 3 and 4.

The most striking feature of the graphs thus far presented is the delay in the secretory response to the test waters administered. This is more marked after ingestion of the stronger saline-alkaline water than of the less highly mineralized alkaline-saline water. It was evident uniformly. In general, the "rebound" in acidity following the period of inhibition elicited by the saline-alkaline water reached higher levels but was more transitory

6. Hellebrandt, F. A.: The Relation Between the Motor and Secretory Functions of the Human Fasting Stomach, Am. J. Physiol. 112:162, 1935.

than the response to the less highly mineralized alkaline-saline water. The control water left the stomach very promptly. The average time before free hydrochloric acid appeared after the usual 500 cc. dose was 17.33 minutes. This was increased by 43 per cent after the ingestion of an equivalent volume of naturally carbonated alkaline-saline water and 97 per cent after the saline-alkaline water. The character of the gastric contents aspirated suggested

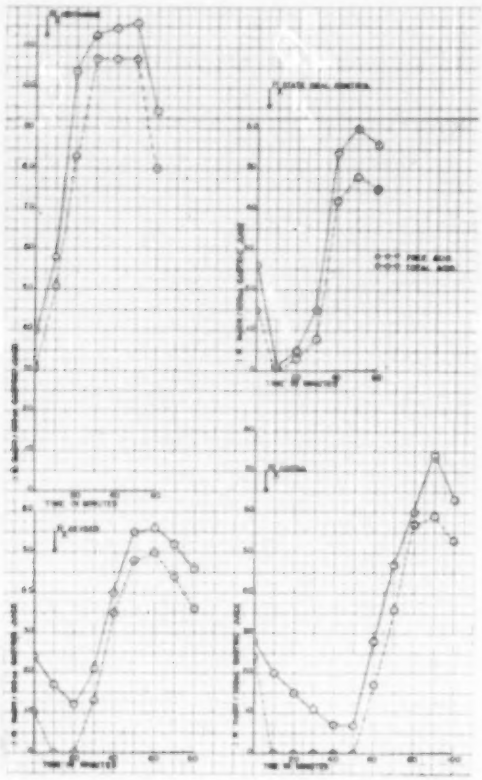

Chart 4. — The subject of these experiments had an asymptomatic hyperchlorhydria. Extensive histamine observations made fifteen years earlier were similar to the current response in all essential respects.

that the mineral waters significantly delayed emptying. Supersaturated solutions of carbon dioxide have a mildly rubefacient effect on the mucosa of the gastrointestinal tract and are said to increase gastric secretion and aid absorption.[7] Lolli and Smith[8] presented evidence suggesting that carbon dioxide plays a prominant role in shortening gastric emptying, but Shapiro and Ivy[9] failed to confirm this. To clarify this point further, simultaneous secretory and motor observations were made.

2. *Double-Intubation Studies.* — Chart 5 epitomizes the results obtained.

7. Goodman, L., and Gilman, A.: The Pharmacological Basis of Therapeutics, New York, The MacMillan Company, 1941.
8. Lolli, G., and Smith, K.: Effervescent Mixtures as Adjuvants to the Rapid Absorption of Ingested Drugs, New Eng. J. Med. 235:49, 1946.
9. Shapiro, K. L., and Ivy, A. C.: Effect of "Carbonation" on the Rate of Gastric Emptying and Intestinal Absorption of Sucrose Solution, Fed. Proc. 7:112, 1948.

The synchronization of gastric secretory and motor function is clearly evident. In general, the acidity of the gastric contents increases as motility augments and subsides with the onset of motor quiescence. The control water passed out of the stomach very rapidly and had a mildly stimulating effect on secretion as previously noted. The height of the secretory cycle coincided with the terminal phases of a period of vigorous peristaltic activity. The delayed secretory response to an equivalent volume of naturally carbonated saline-alkaline water was followed by a long lasting "rebound," during which both free and total acidity not only were significantly augmented but rose to still higher levels with the reappearance of hunger contractions.

Inspectional analysis of the kymograms revealed no effect of carbonated water on motility. Tonus appeared to be increased, but the intervals between the ingestion of the water and the appearance of free hydrochloric acid was invariably characterized by quiescence. Shay and Gerson-Cohen[10] have expressed the belief that changes in tonus are more responsible for gastric

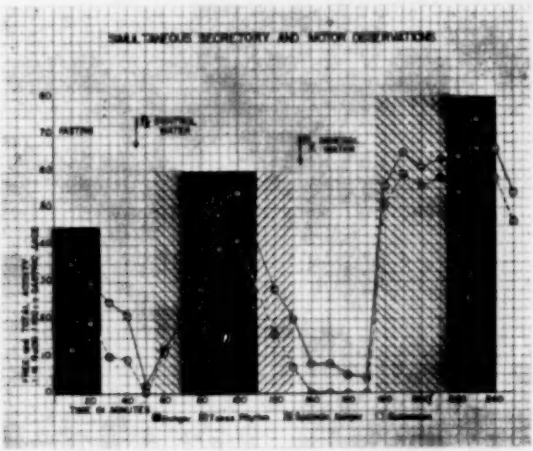

Chart 5. — Synchronization of the secretory and motor functions of the normal stomach under control and experimental conditions.

emptying than peristalsis, its effectiveness being dependent upon the patency of the pylorus. Using improved methods for the study of intralumen pressures of the stomach, Brody, Quigley and their associates[11] have shown that the pylorus is relaxed at least 60 per cent of the time and is not a major factor regulating gastric evacuation. In their fluoroscopic studies, Shay and Gershon-Cohen observed "the barium meal literally pour through the pylorus in a steady stream without the presence in the stomach of the faintest peristaltic wave." The bulk of the various waters ingested in our studies appear also to have been evacuated in this way.

The temperature of the water had no effect on gastric motility. This is

10. Shay, H., and Gershon-Cohen, J.: Experimental Studies in Gastric Physiology in Man. II. A Study of Pyloric Control — The Role of Acid and Alkali, Surg. Gynec. & Obst. **58**:935, 1934.

11. Werle, J. M.; Brody, D. A.; Ligon, E. W.; Read, M. R., and Quigley, J. P.: The Mechanism of Gastric Evacuation, Am. J. Physiol. **131**:696, 1941. Quigley, J. P., and Read, M. R.: The Spontaneous Motility of the Pyloric Sphincter and Its Relation to Gastric Evacuation: the "Pyloric Diaphragm," Am. J. Physiol. **137**:234, 1942. Brody, D. A., and Quigley, J. P.: Intralumen Pressures of the Stomach and Duodenum in Health and Disease, Gastroenterol. **9**:570, 1947.

in accord with the observations of Bisgard and Nye[11] and of Stewart and Baldyreff.[13] It is known that increased motility may be induced by distention of the intact stomach.[14] The absence of motor activity following the ingestion of test and of control waters indicates that the volume administered was within physiologic limits even when added to the fulness induced by the presence of an inflated balloon.

Comment

There has been controversy concerning the effect of antacids on gastric function ever since Claude Bernard observed that sodium bicarbonate stimulated secretion.[15] For many years it was thought that alkali acts as a specific antagonist in the control of gastric hyperacidity. This was, in fact, the basis of the therapeutic use of the mineral waters of such health resorts as Vichy and Carlsbad. Although alkaline waters may exert a temporary neutralizing effect, it was demonstrated subsequently that this is followed by a "rebound" during which gastric acidity is augmented to levels which surpass normal.[16] Crohn, one of the first to note this phenomenon, cites an interesting observation of Linoissier and Lemoine, who saw an anacidity converted to one of hyperacidity by drinking the alkaline waters at Vichy. One of our subjects who had shown a persistent hypoacidity not only responded with higher acidity to the naturally carbonated alkaline waters of Saratoga than to the secretagogue histamine but eventually demonstrated a normal reaction to this stimulant.

The mechanism of the "rebound" is unknown. Adams and coworkers[17] suggested that it may be due in part to stimulation of gastric motility, the diminution in dilution thus increasing the concentration of acid. Shay and Gershon-Cohen[18] and Lolli and Smith[8] expressed the opinion that alkaline salts hasten gastric emptying by virtue of the carbon dioxide liberated, but Shapiro and Ivy[9] were unable to confirm this when carbonated sucrose was ingested. Our own observations likewise failed to demonstrate that carbonated water hastens gastric emptying when administered as a comparatively strong alkaline-saline or saline-alkaline solution. Others (Crohn,[16] Stewart and Baldyreff,[13] Bradley, Schnedorf and Ivy[18] and Gershon-Cohen[19]) had previously observed that alkalis and saline retard emptying, the effect varying with the concentration of the solution.

It has also been postulated that the carbon dioxide released as a result of the reaction of sodium bicarbonate with the hydrochloric acid of the gastric juice is responsible for the secretory excitation. MacLean and Griffiths[20] observed that the oral ingestion of sodium bicarbonate was capable of producing a marked increase in the quantity of carbon-dioxide dissolved in the gastric juice. Babkin[21] introduced carbon dioxide into the fasting stomach

12. Bisgard, J. D., and Nye, D.: The Influence of Hot and Cold Applications Upon Gastric and Intestinal Motor Activity, Surg. Gynec. & Obst. **71**:172, 1940.
13. Stewart, J. F., and Baldyreff, W. N.: Factors Influencing the Passage of Liquids from the Stomach Into the Intestine, Am. J. Physiol. **101**:276, 1932.
14. Lim, R. K. S.; Ivy, A. C., and McCarthy, J. E.: Contributions to the Physiology of Gastric Secretion: I. Gastric Secretion by Local (Mechanical and Chemical) Stimulation, Quart. J. Exp. Physiol. **15**:15, 1925.
15. Bernard, C.: Leçons de physiologie operatoire, Paris, J. B. Bailliere et fils, 1879.
16. Crohn, B. B.: Studies in Fractional Estimation of Gastric Contents: II. Effects of Antacid Medication on Gastric Acidity and Secretion, Am. J. M. Sc. **155**:801, 1918. Lockwood, B. C., and Chamberlin, H. G.: The Effect of Alkalis on Gastric Secretion and Motility as Measured by Fractional Gastric Analysis, Arch. Int. Med. **32**:74, 1923.
17. Adams, W. L.; Welch, C. S., and Clark, B. B.: The Effect of Sodium Bicarbonate on Gastric Secretion, Am. J. Physiol. **139**:306, 1943. Clark, B. B., and Adams, W. L.: The Effect of Gastric Antacids on Gastric Secretion as Observed in the Cope Pouch Dog, Gastroenterol. **9**:784, 1947.
18. Bradley, W. B.; Schnedorf, J. G., and Ivy, A. C.: The Rate of Absorption of Salicylates and the Effect of Certain Compounds on the Rate of Absorption of Acetylsalicylic Acid from the Stomach and Intestine, Am. J. Dig. Dis. **3**:415, 1936-37.
19. Gershon-Cohen, J.: A Duodenal Mechanism Regulating the Motor and Secretory Activity of the Stomach: Its Roentgenographic Disturbance in Duodenal Ulcer, Radiology **48**:232, 1947.
20. MacLean, H., and Griffiths, W. J.: The Factors Influencing the Concentration of Hydrochloric Acid During Gastric Digestion, J. Physiol. **65**:62, 1928.
21. Babkin, B. P.: Does the Stomach Secrete Gastric Juice Continuously? Lilman Anniversary Volumes, New York, The International Press, **1**:113, 1932.

and concluded from the response that it was probably a real stimulant of gastric secretion.

Gases in the gastrointestinal tract are modified by interchange with gases of the blood stream, and carbon dioxide disappears rapidly.[22] Blair, Dern and Bates[23] found that two thirds of the increased volume caused by the ingestion of 500 cc. of carbon dioxide was lost by diffusion into the blood stream in about fifty minutes. Apperly[24] had long postulated that the amount of acid secreted by the gastric mucosa is determined by the carbon dioxide dissolved in the plasma. Kurtz and Clark[25] have recently brought forth new evidence that a relation may exist between the rate of secretion of acid and the tension of carbon dioxide in the gastric tissues and blood. They found that the diffusion of carbon dioxide into the stomach decreases during the active secretion of hydrochloric acid stimulated by histamine. Linking this with the high concentration of carbonic anhydrase known to be present in the parietal cells, they suggested that carbon dioxide is used in some way in the process of hydrochloric acid formation. They postulated that the carbon dioxide is hydrated to carbonic acid in the presence of carbonic anhydrase. The hydrogen is then diverted into the parietal secretion. The bicarbonate ions diffuse into the interstitial fluid and blood in exchange for chloride ions, which combine with the hydrogen to form hydrochloric acid. This may explain the seemingly beneficial effect of naturally carbonated alkaline-saline and saline-alkaline waters on the gastric function of patients with hypoacidity.

Experience indicates that many patients suffering from dyspepsia and chronic gastritis are benefited by the use of selected mineral waters and residence at a health resort or spa. Such patients characteristically demonstrate large quantities of mucus in the gastric secretions, hypoacidity or achlorhydria and rapid emptying with increased peristalsis.[26] That two of these cardinal signs may be reversed by the ingestion of carbonated alkaline waters has already been demonstrated. The third was also affected. It was observed repeatedly that shreds and lumps of precipitated mucus rarely contaminated the juices aspirated after the drinking of the test waters. The tenacious, jelly-like mucus present in the fasting gastric juice of our subject with asymptomatic hypochlorhydria became less and less evident during a simulated course of treatment. Thus direct physiologic studies of the secretory and motor behavior of the stomach substantiate the impressions gained by clinical observation and confirm the belief that naturally carbonated alkaline and saline waters are indicated in the treatment of certain types of gastric dysfunction.

It is not without interest to note that the results produced were attained very largely in the laboratory situation and cannot be attributed to the rest and relaxation, controlled exercise and dietary regulation of the spa regimen. The problem posed is not unlike that surrounding evaluation of the results of modern convalescent care following trauma of the neuromuscular and skeletal systems. The benefits accruing from the application of physiatric procedures is not so effective as their combination with a judicious program

22. McIver, M. A.; Redfield, A. C., and Benedict, E. B.: Gaseous Exchange Between the Blood and the Lumen of the Stomach and Intestines, Am. J. Physiol. **36**:92, 1926.

23. Blair, H. A.; Dern, R. J., and Bates, P. L.: The Measurement of Volume of Gas in the Digestive Tract, Am. J. Physiol. **149**:688, 1947.

24. Apperly, F. L., and Semmens, K.: The Relation of Gastric Function to the Chemical Composition of the Blood: A Preliminary Report, M. J. Australia (Supp.) **2**:153, 1927; Apperly, F. L., and Crahtree, M. G.: The Relation of Gastric Function to the Chemical Composition of the Blood, J. Physiol. **73**:331, 1931.

25. Kurtz, L. D., and Clark, R. B.: The Inverse Relationship of the Secretion of Hydrochloric Acid to the Tension of Carbon Dioxide in the Stomach, Fed. Proc. **5**:189, 1946; Gastroenterol. **9**:594, 1947.

26. Yater, W. M.: Fundamentals of Internal Medicine, New York, Appleton-Century-Crofts, Inc., 1948.

of planned rehabilitation activities. Few would now deny that these adjuvants merit the confidence of the physician. Similarly, empirical experience which has withstood a test of time measured in centuries is certain to have a basis in fact, physiologic in nature. Which of the components exercises the major influence is open to speculation. The tendency to associate gastrointestinal disease with specific emotional patterns has been cited by Thomas[27] as one of the outstanding developments of recent years in the field of gastroenterology, and data of a psychosomatic kind may be found in the exhaustive studies of Wolf and Wolff.[28] Viewing the evidence in toto suggests that simple natural remedies like the drinking of mineral waters, which stem from the age-old practices of mankind, deserve more fundamental study than they have been accorded, so that the good may be made more generally available to those in need of the type of rehabilitation to be had in the spas and health resorts of this country.

Summary and Conclusions

One hundred and twenty-six experiments were performed on 8 normal adult subjects to observe the effect of naturally carbonated saline-alkaline and alkaline-saline mineral waters on the secretory and motor behavior of the stomach and to differentiate the influence attributable to the ingestion of the waters per se from that of the spa regimen. Standard procedures were followed for the study of gastric function. The effect of test waters was compared with that of a noncarbonated, lightly mineralized control water, with the response to the secretagogue histamine and with spontaneous variations in acidity and motility. The evidence presented supports the following deductions:

1. The motor and secretory functions of the normal stomach are intimately related, cycles of increased activity alternating with relative quiescence in synchronous rotation.

2. Naturally carbonated alkaline-saline and saline-alkaline mineral waters increase gastric tonus in the volumes administered for the purpose of these studies.

3. The normal stomach has the ability to evacuate its contents even though there is no evidence of the monophasic pressure waves which characterize antral peristalsis.

4. Gastric tonus may be the motivating force in the emptying of the stomach following the ingestion of naturally carbonated alkaline-saline and saline-alkaline waters.

5. These waters dissolve gastric mucus, inhibit motility, at first depress and then stimulate the secretion of hydrochloric acid.

6. Direct observation thus substantiates the empirical belief that the ingestion of naturally carbonated alkaline-saline and saline-alkaline waters reverses the cardinal signs and symptoms associated with the type of gastrointestinal disturbance known to be benefited by spa therapy.

Our thanks are due to the administrative officers of The Saratoga Spa for providing the waters used in the major aspects of this study and to Dr. Walter S. McClellan for making the laboratory facilities necessary to initiate this investigation available to us. His continued interest and guidance are gratefully acknowledged. Dr. František Rajda of the Balneological Institute at Mariánské Lázně generously furnished the waters which permitted confirmatory observations in Czechoslovakia. These were made in the laboratories of the Institute of Sport Medicine affiliated with the Clinic of Internal Medicine, Charles University, through the kindness of Prof. Jiří Král.

The discussion of this paper will appear in a later issue of the ARCHIVES.

27. Thomas, J. E.: Recent Advances in Gastrointestinal Physiology, Gastroenterol. **12**:545, 1949.

28. Wolf, S., and Wolff, H. G.: Human Gastric Function. An Experimental Study of a Man and His Stomach, London, Oxford Univ. Press, 1947; An Experimental Study of Changes in Gastric Function in Response to Varying Life Experiences, Rev. Gastroenterol. **14**:119, 1947.

DISABILITY EVALUATION *

EARL D. McBRIDE, M.D., F.A.C.S.

OKLAHOMA CITY

The evaluation of physical efficiency is an integral part of medical science for which few criteria for formal training have been developed. Proficiency in these duties still depends greatly on individual experience.

Disability evaluation has become necessary in many spheres of human occupation, such as military service, industrial injuries, veteran's pensions, vocational and rehabilitation readjustment and common court cases of liability.

The basic requirements for evaluating disability arise from the necessity of rating the degree of physical handicap which lowers the ability of a man to fulfil the working duties expected or required of him. Evaluation of disability is not solely that of determining the extent of anatomic or physiologic alterations of the body. The alterations of this kind which limit the physical accomplishments must be evaluated in respect to the duties of employment or the capacity for work.

In military service the determination of fitness for entering the service or the judgment of disability leading to separation is regulated by military rules and practices. In industry the evaluation of disability involves the process of determining the economic loss of working capacity — that is, the basis of physical incapacity entailed from an accident covered by the compensation laws is evaluated in percentage of disability and translated into terms of amounts of money. The laws provide specified awards for amputations at different levels and statutory total permanent disability, such as amputation of both arms or of both legs or total blindness. Such provisions set a limited goal upon which to base partial disability.

The veterans administration schedule of disability likewise specifies various ratings regulating disability which are an economic compromise. The vocational and rehabilitation organizations place disability on an economic basis, in that suitability for the job must be determined before the handicapped person can be established in an occupation.

In liability suits for damages from personal injury there is no schedule upon which to base disability. Exorbitant claims are often made in the hope of a favorable court judgment or settlement. Unfortunately, no extended scientific study has been made with a view of discovering actual wage loss for designated disabilities. The best criterion of the incapacity caused by various types of disability is that of the independent case with no thought of award. The farmer or the man who is his own employer, when no claim is at stake, returns to the job in which he makes his livelihood as quickly as possible. Whatever the physical handicap, he makes his own independent adjustment.

When there is a "claim," a psychogenic factor may be cast upon all angles of the case. The responsibility of loss is thrust upon others than the

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patient alone. A price is put on disability. The expectations of recompense does something to the patient. It may influence his physician as well. There is a neurotic overlay, a mental unrest and a dissatisfaction which the claimant undergoes because of his own apprehension and the delay and uncertainty of decision in his case.

The physician knows well the complexities of nature and human weaknesses. Undue sympathy, ill advised expressions of physicians and lawyers, overoptimism, no estimate of claim, all tend to build up overexpectation.

Examination

The examination in cases involving a claim for disability entail an exceptional investigation that will substantiate or disprove the symptoms described by the claimant. The clinical findings will be: (1) Negative findings. (2) Pathology of recent origin. (3) Pathology preexisting the injury.

Negative clinical findings do not disprove the claim of injury. For example a history of locking of the knee often cannot be substantiated by objective clinical signs yet a ruptured semilunar cartilage is likely to be found if the history is definite and is to be depended upon. The history therefore is important and must consist of a pattern well recognized as indicative of a certain diagnosis.

Pathology of recent origin is readily recognized in such cases as contusion fracture, dislocation, limitation of joint motion, deformity, shortening and scar contractures. Such results of recent injury provide the physiologic basis of disability evaluation.

Preexisting pathology is often a subject of great dispute. For example, such a lesion as a wedged vertebra with no evidence of callous or other signs of recent injury is likely to cause considerable speculative opinion.

Roentgen Examination. — Too often structural variations, such as congenital anomalies in the lumbar portion of the spine, as revealed in the roentgenogram are seized upon for the purpose of proving a desired claim of injury. The significance of such findings in relation to the disability claimed requires much more knowledge than that of just "reading the film."

Partial Ankylosis. — The degree of limited mobility does not measure the degree of disability. Measurement of both active and passive motion must be obtained. It should be made as accurate as possible by use of an arthrometer. The factors of atrophy, pain, swelling, strength and willingness to cooperate must be evaluated in action. Passive motion is tested through relaxation. It should be free and easy motion up to certain points where it is abruptly checked by pain and defensive muscle spasm or by adhesions, bone block or capsule and tendon shortening.

Pain. — Pain is a subjective symptom. It is objective only when it becomes sharp definite tenderness with a response of involuntary muscle spasm. Further evidence to prove the genuineness of pain is localized swelling, deformity, open wound or vasomotor changes that are well recognized as due causes for pain. Facial expression, pupillary dilatation, accelerated pulse rate and increased blood pressure may be correlated with other signs of pain to add to the accuracy of the analysis.

Atrophy. — Muscle atrophy without paralysis is a symbol of disuse. Atrophy

with paralysis is as permanent as the nerve damage. Atrophy can be felt, observed and measured. Loss of strength is in direct proportion to atrophy. Voluntary use of the atrophic muscle is the only hope of restoration. Ankylosis, pain and other limitations of use must be correlated with atrophy and nerve paralysis.

Anesthesia. — Anesthesia is a subjective symptom. It is more frequently observed in the form of hypesthesia or paresthesia. These symptoms may be considered authentic when they conform to a reasonably definite pattern of nerve distribution. Other evidence which further substantiates the genuiness of the symptoms is associated disturbances of other qualities of sensation, such as sense of motion, cutaneous reflex changes, changes of temperature in the affected zone, excessive sweating and trophic changes. Authentic anesthesia usually can be definitely correlated with causes well known to include anesthetic symptoms.

Strength Tests. — There is only one true test for muscular strength and action: the volitional test scientificially applied. It is the only test that takes into account the two elements of muscular action, the contraction of one muscle and the relaxation of its opponent. To test muscle strength one must know (1) the lines along which the muscle acquired its maximum function, as in case of the deltoid or the quadriceps muscles; (2) the effect of gravity; (3) the avoidance of friction — that is, how to place the limb in the position in which the moment of force is greatest; (4) how to place neighboring joints in the position of greatest assistance.

Dynamometers are not reliable because of varying degrees of cooperation effort. It is best to examine the limb systematically and direct the patient to make movements against resistance of the examiner.

Rehabilitation and Adjustment

Partial permanent disability implies a remaining ability to work. However, the result of an injury may change the social, mental, vocational and economic status of the person. The status of disability cannot be termed permanent until the working ability of the person has been restored to its greatest usefulness.

Rehabilitation involves the use of whatever ability is left in the patient to overcome the disability he has acquired. This program consists of (1) surgical or medical reconstruction, (2) application of physical medicine, (3) vocational training, (4) readustment to a suitable job.

In the application of these measures many adverse influences may have arisen to increase the difficulty of rehabilitation. Some of the commoner factors are (1) physiologic alterations, (2) mental and moral characteristics, (3) physical aptitudes, (4) age and social status and (5) occupational opportunities.

Physiologic and anatomic alterations resulting from disability which will respond to surgical reconstruction should receive attention before other measures of rehabilitation are attempted. During this period or after it the disabled person should again be brought into physical harmony with his environment by encouraging repeated effort of useful activity.

The mental and moral influences on the disabled person will depend greatly on his personal characteristics. Natural ability, extent of education, mental reaction toward the personal handicap and willingness to try must be given full weight in evaluation of the possibilities of readjustment. Fear of the loss of a job, the anxiety for the support of the family or the embarrassment of having to return to a less respectable job may greatly bear on the mind of the disabled person.

The physical aptitudes of a person may be concealed behind a curtain of anxiety. Skilful assistance may unveil unknown abilities. Unfortunately, patience and time are usually lacking in the treatment of industrial cases. The alternative to professional supervision and treatment is often that of settlement of the claim and self readjustment.

The age and social status of the injured person is a strong factor in rehabilitation. The older the person, the less the opportunity for employment. The younger the person, the more eager he is to learn. The social aspect may involve family responsibilities, indebtedness or false pride.

Opportunity of employment is perhaps the strongest factor in rehabilitation. There is a great resistance toward employment of the physically handicapped person. The lack of legal protection toward the liability of the employer for the increased risk of further injury often make employment of the crippled person prohibitive. Furthermore, competition in the field of labor is unlimited. There are peaks and valleys in the economic conditions which affect employment and earning power.

The loss of function is the basis of disability evaluation from the medical point of view. If medical opinion can establish what the disabled person can or cannot do, the wage loss of earning capacity or other economic limitations can be settled.

The Functional Measuring Rod of Disability[1]

It has been pointed out in many previous discussions of this subject that function may be divided into a number of factors, each of which when analyzed will contribute toward an understanding of the degree of disability. If each of these factors is given a percentage value, the total will indicate the percentage of disability.

The working capacity of a person will depend on his ability to carry out such activities as lifting, carrying, handling, pushing, pulling, jumping, running, climbing, bending, squatting, throwing or twisting. Such activities, in turn, involve the following fundamentals of function: (1) quickness of action; (2) coordination of movements; (3) strength; (4) security; (5) endurance. Two more factors may be added when applied to industry: (6) safety as a workman, and (7) employability.

If each of these factors is given a percentage of evaluation according to its relative importance to the working capacity, there will then be a suitable measuring rod of disability. The relative value assigned to each of these factors is the following:

1. McBride, E. D.: Disability Evaluation, ed. 4, Philadelphia, J. B. Lippincott Company, 1948.

Quickness of action	10%
Security	10%
Coordination	20%
Strength	20%
Endurance	20%
Safety as a workman	10%
Prestige of physique	10%
Total	100%

The result of applying this measuring rod of disability will vary somewhat according to the goal toward which the evaluation is made. In industry the definition of total disability is established by the statutes in terms of amputation of a limb or the loss of both limbs or both eyes. In other fields the goal of evaluation may be that of a specific vocation or trade, such as that of a carpenter or a railroad brakeman. What would be only partial disability in the general field of labor might be total permanent disability when applied to specific forms of labor. The functional measuring rod provides a definite method of reasoning the extent of disability.

As an example in the use of this measuring rod, one might have a case in which there is a residual permanent limitation of motion in the elbow from full extension to a right angle. The functional measuring rod would be applied as follows:

Delayed action	— 25%; functional factor 10%; disability	2.5
Insecurity	15%; functional factor 10%; disability	1.5
Awkwardness	25%; functional factor 20%; disability	5.0
Weakness	15%; functional factor 20%; disability	3.0
Endurance	15%, functional factor 20%; disability	3.0
Increased risk	10%! functional factor 10%; disability	1.0
Unemployability	15%; functional factor 10%; disability	1.5
		17.7

Functional Tests

In arriving at a conclusion as to the loss of each functional factor in the measuring rod it is sometimes of advantage to apply practical functional tests that can be carried out without special apparatus in the office during the examination. Such tests are conclusive only when the disability has reached a permanent state. When there are still prospects for improvement, functional tests may be applied but the conclusions are somewhat speculative. Bennett[2] has stated, "a functional test . . . deals specifically with the bodily segment employing the use of many muscles working together to achieve certain everyday objectives that are necessary for the patient to live effectively in a normal environment."

The functional tests appended are for the purpose of bringing to light a clearer knowledge of the disabled person's ability to apply himself at work. Each test has a value of 10 per cent of each functional factor on the measuring rod of disability. A summary of the ratings of the tests should not be used as a final opinion on the extent of disability. The fundamental tests will serve as a method of professional analysis of the disability which is anticipated in the return of the injured person to his field of labor.

2. Bennett, R. L.: Functional Testing and Training in Physical Medicine, Arch. Phys. Med. **30**: 265, 1949.

Disability Tests

TABLE 1. — *Ten Functional Tests for the Hand and Fingers.*

Test	Quickness, 10%	Security, 10%	Coordination, 20%	Strength, 20%	Endurance, 20%	Risk, 10%	Employment, 10%	Disability Evaluation
(Example: Arc of motion of all fingers limited from full extension to 50° flexion.)								
1. Take hold of one corner of a page of newspaper, crumple up into palm Normal time — 10 seconds								
Grade	7	5	12	10	10	5	7	....
Value of test — 10%	0.3	0.5	0.8	1.0	1.0	0.5	0.3	4.4
2. Cut with scissors a column of news from newspaper Normal time — 10 seconds								
Grade	4	3	8	15	10	5	5	....
Value of test — 10%	6	7	12	0.5	1.0	0.5	0.5	5.0
3. Button shirt, one button only Normal time — 20 seconds								
Grade	5	6	10	15	10	5	5	....
Value of test — 10%	0.5	0.4	1.0	0.5	1.0	0.5	0.5	4.4
4. Tie knot in cotton string (injured hand only) Normal time — 20 seconds								
Grade	6	7	12	20	18	7	8	....
Value of test — 10%	0.4	0.3	0.8	0	0.2	0.3	0.2	2.2
5. Pick ten pieces of paper from smooth surface Normal time — 20 seconds								
Grade	6	6	12	17	18	7	8	....
Value of test — 10%	0.4	0.4	0.8	0.3	0.2	0.3	0.2	2.6
6. Clap open hands together ten times Normal time — 5 seconds								
Grade	9	8	15	10	18	8	8	....
Value of test — 10%	0.1	0.2	0.5	1	0.2	0.2	0.2	2.4
7. Pick up chair by holding to one of its legs with injured hand only Normal time holding off floor — 5 seconds								
Grade	9	7	16	5	3	5	5	....
Value of test — 10%	0.1	0.3	0.4	1.5	1.7	0.5	0.5	5.0
8. Wring dry a wet towel using both hands Normal time 15 seconds								
Grade	8	7	12	5	3	7	7	....
Value of test — 10%	0.2	0.3	0.8	1.5	1.7	0.3	0.3	5.1
9. Squeeze examiner's hand full strength 6 times Normal time — 5 seconds								
Grade	8	7	15	5	5	8	8	....
Value of test — 10%	0.2	0.3	0.5	1.5	1.5	0.2	0.2	4.4
10. Pick up 2 medium-sized books injured hand only; place on shelf and remove 5 times Normal time — 20 seconds								
Grade	5	6	15	12	15	8	8	....
Value of test — 10%	0.5	0.4	0.5	0.8	0.5	0.2	0.2	3.1
Total Extent of Disability								38.6

TABLE 2. — *Ten Functional Tests for the Hand, Wrist, Elbow and Shoulder.*

Test	Quickness, 10%	Security, 10%	Coordination, 15%	Strength, 20%	Endurance, 20%	Risk, 10%	Employment, 10%	Total Evaluation
(Example: Elbow partial ankylosis, limited from 180° extension to 135° flexion.)								
1. Take a large book from examining table, lift forward and upward to overhead shelf and replace 5 times								
Normal time — 15 seconds								
Grade	8	7	10	15	15	7	7	....
Value of test — 10%	0.2	0.3	1.0	0.5	0.5	0.3	0.3	3.1
2. Repeat no. 1 by turning back to the shelf and lifting book upward and backward to shelf 5 times								
Normal time — 15 seconds								
Grade	5	4	8	10	10	6	7	....
Value of test — 10%	0.5	0.6	1.2	1.0	1.0	0.4	4.3	5.0
3. Repeat no. 1 by turning right side to the shelf and lifting book upward and to the right of the shelf 5 times								
Normal time — 10 seconds								
Grade	3	3	7	10	8	6	7	....
Value of test — 10%	0.7	0.7	1.3	1.0	1.2	0.4	0.3	5.6
4. Same as no. 3 with left side to shelf and lifting book toward left side								
Normal time — 10 seconds								
Grade	3	2	6	7	8	6	7	....
Value of test — 10%	0.7	0.8	1.4	1.3	1.2	0.4	0.3	6.1
5. Take large book in hand and place on corresponding shoulder 5 times								
Normal time — 5 seconds								
Grade	2	1	3	2	5	3	2	....
Value of test — 10%	0.8	0.9	1.7	1.8	1.5	0.7	8.0	8.2
6. Take examiner's hand and pull him forward against resistance, start with arm extended and accomplish full flexion 5 times								
Normal time — 15 seconds								
Grade	7	8	5	5	5	5	5	....
Value of test — 10%	0.3	0.2	1.5	1.5	1.5	0.5	0.5	1.0
7. Same as no. 6 except push examiner away starting with elbow flexed 5 times								
Normal time — 15 seconds								
Grade	6	5	5	3	3	7	7	....
Value of test — 15%	0.4	0.5	0.5	1.7	1.7	0.3	0.3	5.0
8. Take large book in hand, arm full extension at side, bring firmly into axilla 5 times								
Normal time — 10 seconds								
Grade	5	2	2	5	5	8	9	....
Value of test — 10%	0.5	0.8	1.8	1.5	1.5	0.2	0.1	5.0
9. Lie on face, do push-up with both arms 3 times								
Normal time — 10 seconds								
Grade	8	8	10	12	5	7	6	....
Value of test — 10%	0.2	0.2	1.0	0.8	1.5	0.3	0.4	4.4
10. Stand with back to light examining table, lift table with arms only 6 times, 5 times								
Normal time — 15 seconds								
Grade	7	6	15	10	8	7	8	....
Value of test — 10%	0.3	0.4	0.5	1.0	1.2	0.3	0.2	3.9
Total Extent of Disability								47.3

TABLE 3. — *Ten Functional Tests for the Foot, Ankle, Knee and Hip.*

Test	Quickness, 10%	Security, 10%	Coordination, 20%	Strength, 20%	Endurance, 10%	Risk, 10%	Employment, 10%	Disability Evaluation
(Example: Partial ankylosis of knee; limited from 180° extension to 45° flexion.)								
1. Walking on tiptoe 10 steps Normal time — 5 seconds Grade	8	7	8	15	12	9	8	
Test value — 10 %	0.2	0.3	1.2	0.5	0.8	0.1	0.2	3.3
2. Walking on heels 10 steps Normal time — 7 seconds Grade	7	6	6	12	10	8	8	
Test value — 10%	0.3	0.4	1.4	0.8	1.0	0.2	0.2	3.3
3. Walking on outer part of feet 10 steps Normal time — 5 seconds Grade	9	8	16	18	16	9	9	
Test value — 10%	0.1	0.2	0.4	0.2	0.4	0.1	0.1	1.5
4. Standing, place toes under round of a chair; left and replace chair 10 times Normal time — 20 seconds Grade	6	7	12	10	10	5	5	
Test value — 10%	0.4	0.3	0.8	1.0	0.1	0.5	0.5	4.5
5. Step over a chair and back with injured leg 5 times Normal time — 12 seconds Grade	0.3	4	7	15	10	4	4	
Test value — 10%	0.7	0.6	1.3	0.5	1.0	0.6	0.6	4.3
6. Stand on injured leg, step over chair and back with well leg 5 times Normal time — 15 seconds Grade	2	1	3	8	7	3	3	
Test value — 10%	0.8	0.9	1.7	1.2	1.3	0.7	0.7	7.3
7. Squat down on heels, take 10 steps Normal time — 75 seconds Grade	4	5	10	12	10	6	8	
Test value — 10%	0.6	0.5	1.0	0.8	1.0	0.4	0.2	4.5
8. Step up and down on 9 inch stool 10 times using injured leg Normal time — 75 seconds Grade	5	6	10	15	12	7	8	
Test value — 10%	0.5	0.4	1.0	0.5	0.8	0.3	0.2	3.7
9. Place book on toes, throw up in air and catch; repeat 3 times Normal time — 10 seconds Grade	6	5	10	12	12	7	8	
Test value — 10%	0.4	0.5	1.0	0.8	0.8	0.3	0.2	4.0
10. Jump from stool 9 inches high, landing squarely on both feet Grade	7	5	8	10	10	7	8	
Test value — 10%	0.3	0.5	1.2	1.0	1.0	0.3	0.2	4.5
Total Extent of Disability								40.9

TABLE 4. — *Ten Functional Tests for the Back.*

Test	Quickness, 10%	Security, 10%	Coordination, 20%	Strength, 20%	Endurance, 20%	Risk, 10%	Employment, 10%	Disability Evaluation
(Example: Fracture of first vertebra; lumbar; free motion, no muscle spasm; pain up to 50% normal.)								
1. Bend forward, pick up 2 large books, straighten up and replace 5 times								
Normal time — 20 seconds								
Grade	7	8	12	15	10	7	6	...
Test value — 10%	0.3	0.2	0.8	0.5	1.0	0.3	0.4	3.5
2. Take hold of legs of light examining table at the floor and lift 6 inches 5 times								
Normal time — 15 seconds								
Grade	6	7	12	10	7	7	4	...
Test value — 10%	0.4	0.3	0.8	1.0	1.3	0.3	0.6	4.7
3. Climb up and down on examining table to squatting position 5 times								
Normal time — 25 seconds								
Grade	7	8	18	15	12	8	8	...
Test value — 10%	0.3	0.2	0.2	0.5	0.8	0.2	0.2	2.4
4. Stand, left leg straight, stoop over, pick up book and replace 5 times								
Normal time — 10 seconds								
Grade	6	7	15	12	10	8	8	...
Test value — 10%	0.4	0.3	0.5	0.8	1.0	0.2	0.2	3.4
5. Same as no 4 except keep right leg straight								
Normal time — 10 seconds								
Grade	6	7	15	12	10	8	8	...
Test value — 10 %	0.4	0.3	0.5	0.8	1.0	0.2	0.2	3.4
6. Stand, back and hips squarely against examining table, reach around to the back and pick up 2 large books, bring around frontwise to opposite side and replace on table behind back; repeat 5 times								
Normal time — 15 seconds								
Grade	7	7	17	18	15	9	9	...
Test value — 10%	0.3	0.3	0.3	0.2	0.5	0.1	0.1	1.8
7. Hold to doorknob of latched door with both hands, back and heels to door; sway abdomen forward 8 inches and touch head backward to door 10 times								
Normal time — 15 seconds								
Grade	6	7	15	17	15	9	9	...
Test value — 10%	0.4	0.3	0.5	0.3	0.5	0.1	0.1	2.2
8. Hold to doorknob of latched door, sit down and get up 5 times								
Normal time — 15 seconds								
Grade	7	9	15	18	17	9	9	...
Test value — 10%	0.3	0.1	0.5	0.2	0.3	0.1	0.1	1.6
9. Hold to doorknob of latched door, one hand, right side to door, bend to the left keeping right leg straight, pick up book and replace 5 times								
Normal time — 15 seconds								
Grade	6	7	15	12	10	8	8	...
Test value — 10%	0.4	0.3	0.5	0.8	0.1	0.2	0.2	3.4
10. Repeat, opposite side								
Grade	5	6	12	12	10	8	8	...
Test value — 10%	0.5	0.4	0.8	0.8	1.0	0.2	0.2	3.9
Total Extent of Disability								30.3

WHAT EVERY PHYSICIAN SHOULD KNOW ABOUT THE HOSPITAL PRACTICE OF PHYSICAL MEDICINE AND REHABILITATION *

W. D. PAUL, M.D.

IOWA CITY

In hospital practice the department of physical medicine has many functions to carry out in addition to the routine treatment of patients. The first of these functions is to provide a consulting service to aid in the diagnosis of certain diseases and in outlining types of therapy. The physician trained in physical medicine must have more detailed knowledge of certain diseases such as arthritis, peripheral vascular disease, poliomyelitis, peripheral nerve injuries, cerebral palsy and spinal cord injuries, to name a few. During epidemics of poliomyelitis many patients who have other virus infections, such as neuronitis or choriomeningitis, are admitted to hospitals and these must receive correct diagnoses and be properly treated. The physiatrist also is trained in use of special diagnostic instruments and methods. The thermocouple, oscillometer, plethysmograph, faradic and galvanic currents, Geiger counter, goniometer, ergometer and electromyograph are used both as an aid in diagnosis and in following the results of treatment. Methods of evaluating muscle function are necessary to follow the progress of the patient with poliomyelitis.

The lack of bed space in all hospitals makes it desirable to reduce the length of hospitalization as much as possible. Early ambulation not only helps shorten the period of hospitalization but may prevent complications such as thrombophlebitis or pulmonary infections. The physical therapists are taught the technics of early ambulation and practice them under supervision of the physiatrist. More recently, low frequency currents have been used to prevent thrombophlebitis following surgical procedures. The oscillating bed and tilt table have been employed as means of reducing the incidence of bladder and renal stones in patients immobilized for long periods. Decubitus ulcerations can also be averted by the use of exercises and ultraviolet irradiation.

The most important function of a department of physical medicine is the treatment and rehabilitation of the sick and injured. Treatment with physical aids can be divided into several categories. Some patients need treatment during their stay in the hospital, while others need only an outlined schedule of treatment which can be carried out at home, in the referring physician's office or in an outpatient clinic. Another group of patients need intensive therapy while in the hospital and little or none after discharge.

What form of treatment should a patient receive? Like most types of therapy, treatment by physical means cannot be made a standardized procedure but must vary from patient to patient. When an internist prescribes digitoxin, he knows not only the dose of the drug and the effect desired but also the pharmacologic and physiologic effects of the drug. In the past little was known of the effects of the modalities used in physical medicine. Heat and massage were prescribed empirically, and the major problems in the field consisted of a choice between petrissage or kneading and the types of heat to be employed. For a time physical medicine became synonymous with

* From Department of Internal Medicine, Division of Physical Medicine, College of Medicine, State University of Iowa.

the use of all types of apparatus. New instruments appeared, each designed to produce a specific therapeutic effect and each requiring special knowledge of application. Departments of physical medicine were graded not on results obtained but on the number and types of machines used.

Through the efforts of the Baruch Committee on Physical Medicine and the National Foundation of Infantile Paralysis, Inc., physical medicine has undergone many changes. With the aid of generous gifts from these agencies, considerable research was undertaken to study the basic effects of heat, cold, exercise, low and high frequency currents, hydrotherapy and phototherapy. Since this research is in its early stages, we still have much to learn about the modalities we use daily. The success achieved in the treatment of poliomyelitis is an example of the accomplishments made possible by combining the research facilities of the preclinical and clinical sciences.

Not all departments of physical medicine in hospitals can carry out basic research. Yet each department can and should contribute its share in furthering the cause of physical medicine. The problems of most interest to the department and the physicians on the staff will depend on the type of hospital and its location. If the hospital is in an industrial center and most of the staff physicians treat industrial diseases, some of the problems that could be investigated would be a study of the life history of certain injuries and evaluation of the effects of definite methods of treatment. In addition, the physiatrist might be interested in working in a shop to develop new and more efficient braces or splints. In a general hospital the problems are different and the interest of the staff will determine the type of investigations to be pursued. When the physician in general practice or in the specialties inquires as to the rationale of a particular form of therapy, he is entitled to the most complete information that can be supplied. The average physician does not have the time or the selection of patients to carry out a research program; therefore it must be made a function of the physical medicine departments in the various hospitals.

As indicated before, some patients remain in a hospital only a short time and whatever treatment is recommended is carried on at home, in the local physician's office or in an outpatient clinic. The treatment outlined must be adapted to the needs of the patient and the facilities that are available in his home or his physician's office. In many parts of the country the majority of patients are from rural communities and do not have the facilities of their urban cousins. The first problem of the physical medicine department is the proper instruction of these persons to accomplish the prescribed treatment. This cannot be done by giving the patient a treatment and a typewritten sheet of instructions. The instruction has to be individualized as it does when one is instructing a patient in a special diet. Everyone realizes the fallacy of handing a patient a typewritten or printed diet list without first asking regarding his age, race, geographic location and economic status. By the same token it is necessary before instructing a patient in physical therapy treatments to know something of his home environment. For example, are there adults in the household (to assist the patient); does the house have running water or a pump; does it have a bathroom on the same floor as the bedroom; does the patient live in a small apartment with only a shower stall? One must also find out the economic status of the patient and, more important, his occupation. Physicians who apparently still believe in mysticism ask patients to take drugs or a physical remedy every three or four hours, forgetting that the patient cannot interrupt his particular employment every three or four hours. If I were instructing a farmer suffering

from arthritis as to proper home treatment, I should suggest heat, exercise, massage and, perhaps, night splints. In this case the use of hot packs or paraffin baths would be advisable. Exercises would be suggested that could be carried out on a farm, as, for instance, milking a cow, grinding a disk or axe, pumping water, or raising or lowering a pulley. If the patient is an office worker in a city, then one could use an electric lamp for heat, a typewriter or piano for exercise, an awning rope thrown over a door for shoulder exercise or pumping the treadle of a sewing machine while playing bridge. It must be impressed upon the patient that he must return to his own physician at definite intervals so that the progress of the "treatment" can be observed.

At the present time much stress is being given to the subject of rehabilitation. The average hospital cannot afford to set up a complicated, coordinated rehabilitation service, nor does it have the number of patients necessary to keep such a service functioning. Another problem overlooked by many enthusiasts is the fact that the average patient cannot afford to remain in a hospital for complete rehabilitation. The departments of physical medicine can do a great deal in rehabilitating the crippled patient. The first steps are to gain the patient's confidence and to instill in him a desire to get better. While he is in the hospital, an attempt is made to strengthen the extremities not affected and to teach him how to sit up, get in and out of bed and, if possible, how to get on and off a toilet seat or commode. Then it may be necessary to devise a series of exercises and apparatus so that the patient can continue the treatments at home. The patient's physician must also be completely informed as to the program so that he can supervise and guide the patient after he returns home. Most of the special apparatus needed for these patients is expensive, but practically all of it can be built in the hospital or at home, reducing the cost of the apparatus and adapting it to the patient's individual needs.

The hospital practice of physical medicine is no different from the hospital practice of any other specialty. Most of the patients treated usually suffer from chronic illnesses and must spend considerable time at home and be seen often by their physician or an out-patient clinic. A well organized department can help reduce the number of days the patient spends in the hospital by early ambulation, bed exercises, preoperative and postoperative breathing exercises, proper handling of stumps following amputation or use of phototherapy in certain dermatologic conditions. Besides treating a patient, the physical medicine department can be used to aid in diagnosis and as a center to carry out either clinical or preclinical investigations.

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.·. EDITORIALS .·.

NEEDS IN EDUCATION IN PHYSICAL MEDICINE AND REHABILITATION

At the Educational Conference held during the meeting of the American Congress of Physical Medicine in Cincinnati in September, 1949, it was recommended that representatives of that group (the conference was attended by people primarily interested in education in physical medicine and rehabilitation and Consultants on Education to the Council on Physical Medicine and Rehabilitation) be sent to the sixtieth annual meeting of the Association of American Medical Colleges, to be held at the Broadmoor Hotel in Colorado Springs, Nov. 7 to 9, 1949. The Association of American Medical Colleges is attended by the deans of all the medical colleges, and many of their staff members, and is concerned with undergraduate and graduate medical education. The purpose of sending representatives to this meeting was to have them, if possible, take part in the discussion of undergraduate medical education as it relates to the development of physical medicine and rehabilitation.

One of the three panel discussions at the meeting was concerned with the undergraduate curriculum planning. The Association very kindly allowed the three representatives from the group interested in physical medicine to present some of their problems during the panel discussions. The representatives, Drs. Kendell, Dinken and Elkins, stressed that some of the problems in education in physical medicine were as follows: (1) lack of means by which the medical student can be oriented in what constitutes physical medicine and rehabilitation; it was suggested that this might be partially done by orientation courses and integration with existing courses during the preclinical years of training, and (2) the needs for well organized departments of physical medicine with well-trained physiatrists in charge. The physiatrists pointed out that without actual practice of physical medicine by a well trained physiatrist, in a teaching hospital, the medical student or intern could not be given the general knowledge of physical medicine and rehabilitation that he should have for the practice of many branches of medicine.

Some of the general factors as to why there is a need for more education in the field were pointed out; namely, (1) that physical medicine and rehabilitation is now a recognized specialty; (2) that there is now a permanent Section on Physical Medicine and Rehabilitation in the American Medical Association; (3) that in a well organized medical center, 10 per cent or more of all patients examined are treated in a department of physical medicine (even larger numbers may be treated if there were space and other facilities to do so); (4) that it would seem logical, therefore, since there is a trend toward extension of the field, where available, and since present philosophic concepts of rehabilitation will require a broad knowledge for its practice, more attention could and should be paid to teaching on the undergraduate level; (5) that the only logical way to develop good teaching is to have a well organized separate department of physical medicine and rehabilitation in the

teaching hospital of the medical school, with physicians of professional rank carrying on activities in the field, just as they were carried on in other fields. It was pointed out that in a few centers there is already integration of the basic sciences with physical medicine, and orientation courses are being given without actually changing the number of hours in the curriculum.

During an informal discussion, several deans indicated interest in a teaching program and the establishing of departments of physical medicine and rehabilitation. The greatest need indicated was for competent physiatrists to head such programs. This again stresses the need for all physiatrists who are in a position to do so, to increase their undergraduate and graduate training programs for physicians, to provide an adequate supply of teachers for the future.

Those in physical medicine and rehabilitation greatly appreciate the opportunity to have presented some of their problems to the Association of American Medical Colleges, and it is hoped that the physiatrists may again take part in the proceedings of the Association of American Medical Colleges in the years to come.

THE HOSPITAL DEPARTMENT OF PHYSICAL MEDICINE

The size, equipment and organization of hospital departments of physical medicine will vary somewhat according to local needs. Some of the determining factors are: the bed capacity of the hospital, the length of the patient stay, the most common diseases treated, the economic status of the patients, the medical staff organization and whether or not there is an outpatient department.

The functions of the hospital department of physical medicine are: (1) Patient care, both diagnostic and therapeutic; (b) education of the nursing, interne, and resident staffs, and, possibly, even the attending staff; (3) research. These functions will vary from hospital to hospital depending on local conditions, but they are still basic.

The personnel of the department of physical medicine should, of course, be headed by a physiatrist, if available, or at least by a physician with some special training in physical medicine. It is a recognized fact, that, at present, fully qualified physiatrists are in short supply. The technical staff should include an adequate number of fully qualified physical therapists and occupational therapists one of whom should be designated as chief. If the hospital is undertaking a rehabilitation program, some of the physical therapists should have a period of special training in this phase of physical medicine.

In the average sized general hospital, there should be a department of physical medicine capable of carrying out all of the common diagnostic and therapeutic procedures which modern physical medicine comprehends. In the diagnostic field, this includes electrical and functional muscle testing, temperature studies, oscillometry, goniometry, electromyography, and, in some instances, rehabilitation grading. The physiatrist should act as a consultant to aid in the diagnosis and treatment of diseases in which physical medicine is especially concerned, a few of which are: poliomyelitis, cerebral palsy, the peripheral vascular diseases, the rheumatic diseases and lesions of the peripheral nerves.

In the therapeutic realm, the department of physical medicine should be prepared to cooperate with the various clinical departments in their therapeutic problems. At the present time, physical measures have found places of varying importance in most of the medical and surgical specialties. The ultimate place of physical medicine in relation to the therapeutic care of medical

cases is certainly not yet fully determined. There are many unexplored possibilities beyond the use of physical measures in the rheumatic diseases."

In the realm of surgery, ultraviolet irradiation of the air of the operating room and early mobilization and ambulation in the postoperative care are examples of the value of the physical procedures. Physical and occupational therapy have much to offer the orthopedist in the after care of fractures, amputations, dislocations, sprains and corrective procedures. To neurology and psychiatry, physical medicine offers aid in the care of cerebral palsies, cord lesions, peripheral nerve injuries and the various psychoses. Poliomyelitis, of course, is peculiarly the responsibility of the physical medicine staff with the help of such other specialists as may seem indicated in individual cases. The dermatologist, the urologist, the otolaryngologist and the ophthalmologist all find certain of the physical measures useful.

The department of physical medicine has a definite educational function. In its present stage of development, there is constant need for placing before the interne, resident and attending staffs of the hospital, at every opportunity, the value of physical medicine in the diagnostic and therapeutic care of patients. This may be done at staff meetings, departmental conferences and personal interviews. Where local conditions permit, the regular publication of a departmental bulletin containing abstracts and notes on current progress in physical medicine is exceedingly valuable.

The well organized department of physical medicine should have an interest in research, either independently or in conjunction with other departments. Practically every department with adequate medical direction can carry on some original study if there exists the will to do so. Joint research projects are especially valuable in promoting a cooperative spirit between physical medicine and the other specialties.

In this issue of the ARCHIVES, will be found an excellent article on the hospital practice of physical medicine by Dr. W. D. Paul. It is well worth the perusal of the interested reader.

IMPORTANT NOTICE

Certified diplomates of the American Board of Physical Medicine and Rehabilitation who wish to replace their certificate which carried the former name, American Board of Physical Medicine, may order a replacement certificate at a cost of $3.00. Orders and checks should be sent to the American Board of Physical Medicine and Rehabilitation, 30 North Michigan Ave., Chicago 2, Illinois.

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Advances in Education

Earl C. Elkins, M. D., Chairman.
Frances Baker, M.D.
Kristian G. Hansson, M.D.
George M. Piersol, M.D.
Donald L. Rose, M.D.

Constitution and By-Laws

William H. Schmidt, M.D., Chairman.
Walter S. McClellan, M.D.
Fred B. Moor, M.D.

Cooperation With Army, Navy, Public Health and Veterans Administration

Alvin B. C. Knudson, M.D., Chairman.
Anthony A. Tratar, M.D.
Arthur E. White, M.D.

Cooperation with Food and Drug Administration

Charles S. Wise, M.D., Chairman.
Gervais J. P. Barger, M.D.
Karl Harpuder, M.D.
Arthur C. Jones, M.D.
Gordon M. Martin, M.D.
Sedgwick Mead, M.D.
Nathan S. Polmer, M.D.

Finance

Frank H. Krusen, M.D., Chairman.
Roy W. Fouts, M.D.
Walter M. Solomon, M.D.

Foster, Encourage and Co-ordinate Research Projects

Arthur L. Watkins, M.D., Chairman.
Robert W. Boyle, M.D.
Frederic J. Kottke, M.D.

Gold Key Awards

Walter M. Solomon, M.D., Chairman.
George G. Deaver, M.D.
O. Leonard Huddleston, M.D.
Sidney Licht, M.D.
Charles O. Molander, M.D.

Legislation

H. Worley Kendell, M.D., Chairman.
Donald J. Erickson, M.D.
Frederic T. Jung, M.D.

Medical Economics

George D. Wilson, M.D., Chairman.
William Bierman, M.D.
Arthur M. Pruce, M.D.

Meeting Place

Walter J. Zeiter, M.D., Chairman.
Nila Kirkpatrick Covalt, M.D.
Harold Dinken, M.D.
H. Worley Kendell, M.D.
William H. Northway, M.D.

Membership

Richard Kovács, M.D., Chairman.
Ben L. Boynton, M.D.
Clarence Dail, M.D.
Max K. Newman, M.D.
George M. Piersol, M.D.

Nominating

O. Leonard Huddleston, M.D., Chairman.
Miland E. Knapp, M.D.
Frank H. Krusen, M.D.
Walter S. McClellan, M.D.
Fred B. Moor, M.D.

Problems Affecting Physical Therapy and Occupational Therapy Technicians

Fred B. Moor, M.D., Chairman.
Frances Baker, M.D.
Shelby Gamble, M.D.

Public Relations

Frank H. Krusen, M.D., Chairman.
Robert L. Bennett, M.D.
William H. Schmidt, M.D.

Awards for Scientific Exhibits

Robert W. Boyle, M.D., Chairman.
Wayne McFarland, M.D.
Sedgwick Mead, M.D.

MEDICAL NEWS

New York Society of Physical Medicine

At a recent meeting of the New York Society of Physical Medicine the following program was presented: "Electrophrenic Respiration," slides, color movie, by Stanley J. Sarnoff, M.D., Assistant Professor of Physiology, Harvard University School of Public Health (by invitation). The discussion was opened by Philip M. Stimson, M.D. (by invitation).

Pennsylvania Academy of Physical Medicine

The following program was presented at the recent meeting in Philadelphia of the Pennsylvania Academy of Physical Medicine: "Rehabilitation of the Paraplegic," by Dr. Charles Furey; "Report On Cerebral Diathermy in Hemiplegia," by Dr. Elmer J. Elias, and "Hemiplegia In a Child," by Dr. Francis J. Bonner.

New Jersey Society of Physical Medicine

Dr. Joseph Rubacky was the chief speaker and presented a discussion on "Evaluation of Disability" at a recent meeting of the New Jersey Society of Physical Medicine, held at St. Mary's Hospital, Passaic, N. J.

The next meeting of the New Jersey Society of Physical Medicine will be held Jan. 25, 1950, at the Nurses' Home, Mercer Hospital, Trenton, New Jersey, according to announcement of Dr. James C. Hanrahan, Secretary. The program will consist of papers by Dr. Elmer J. Elias, "Transcerebral diathermy in the treatment of cerebrovascular accidents, with case presentations of rehabilitation phases," and "Modern concepts of physical medicine in the treatment of dermatological conditions," presented by Dr. Paul Kline.

Dr. Russek Appointed

The appointment of Dr. Allen S. Russek as Assistant Professor of Physical Medicine and Rehabilitation and Coordinator for Research and Education of the Department of Physical Medicine and Rehabilitation, New York University College of Medicine, has been announced by Dr. Currier McEwen, Dean of the College. A diplomate of the American Board of Physical Medicine and Rehabilitation, Dr. Russek, prior to his new assignment, was orthopedic surgeon and physician-in-charge of physical medicine at the U. S. Marine Hospital, Stapleton, Staten Island, New York.

National Society News

A survey among physically handicapped adults who are in need of specially designed homes that will help to restore them to useful activities is being conducted by the National Society for Crippled Children and Adults.

The National Society, the Easter Seal Agency, has embarked upon a program designed to find out what the housing needs are for handicapped homemakers. From this survey, the Society will prepare a digest of suggestions and ideas for designers, engineers and architects who will work on this model home project.

John R. Powers, Jr., has been appointed director of Fund Raising and Information Services for the National Society for Crippled Children and Adults, Chicago. Powers will be responsible for the planning, activating, administration and coordination of the National Society's fund raising activities. He will also assist in preparing and producing publicity aids for the Society's Annual Easter Seal campaign.

General Armstrong Sworn In as Air Force Surgeon General

Major General Harry G. Armstrong was sworn in as Surgeon General of the U. S. Air Force Medical Service. General Armstrong succeeds Major General Malcolm C. Grow, who retired on November 30.

General Armstrong, an authority on aviation medicine, was a winner of the Collier Award for aviation achievement in 1939. He first took an interest in the relation of medicine to flying while in private practice in Minneapolis, Minnesota, after his graduation from the University of Louisville Medical School in 1925.

VA News

Veterans Administration has announced that Dr. John B. McHugh, chief of professional services at the Outwood, Kentucky, V-A Hospital, will serve as manager of the V-A hospital under construction at Minot, North Dakota.

Veterans Administration has announced that Dr. Michael L. Matte, Chief Medical Officer at the V-A Center, Wood, Wisconsin, will succeed Dr. Robert C. Cook as Manager of the V-A Hospital, Fort Logan, Colorado. Dr. Matte's appointment is effective January 22, 1950, the date on which Dr. Cook will become Assistant Chief Medical Director in Central Office.

Grants to Extend Physical Medicine Program

Gifts totaling $550,000, one from Bernard M. Baruch and the other from the Louis J. and Mary E. Horowitz Foundation, Inc., both to be devoted to the advancement of the work of the Institute of Physical Medicine and Rehabilitation of the New York University-Bellevue Medical Center,

were announced November 30. Mr. Baruch gave $450,000 to the Medical Center and the Horowitz Foundation made a gift of $100,000. The two gifts will be applied to the construction of that section of the Medical Center which will house the Institute of Physical Medicine and Rehabilitation in its new permanent home. An allocation of $250,000 from the Baruch Committee on Physical Medicine and Rehabilitation made possible the establishment of the department of physical medicine and rehabilitation of New York University College of Medicine, the first such major department in any medical school in the nation. In 1948, Mr. Baruch also contributed toward the refitting of the present temporary quarters of the Institute of Physical Medicine and Rehabilitation at 325 East 38th Street in a building made available by the Milbank Memorial Fund. The institute's program has recently been strengthened, after the extended trip through Europe by Dr. Howard A. Rusk, professor and chairman of the department, in his capacity as consultant in rehabilitation to the World Health Organization of the United Nations. Physicians from Poland, Holland, Norway, Czechoslovakia, Israel and Austria are studying the long range program of research, teaching and medical care of the institute. These physicians will return to their own countries to establish simliar programs. Physicians from India and China are also training at the institute which has a waiting list of patients from all parts of the United States. When the new quarters are completed the institute will double its capacity; it will be equipped to care for 100 inpatients and 200 outpatients per day.

Apparatus Accepted

Radiosurg Scalpel Model R-1. — The Radiosurg Scalpel is an electrotome or electric knife in which an arrangement of three vacuum tubes is used to produce radio-frequency currents for cutting, coagulation, hemostasis, fulguration and sterilization. The Council on Physical Medicine and Rehabilitation voted to include the model in its list of accepted devices.

Mother's Pal Pillow. — The pillow is designed to support the abdomen of the pregnant woman during sleep. The Council on Physical Medicine and Rehabilitation voted to include the apparatus in its list of accepted devices.

Chestpirator Portable Chest Respirator. — The Chestpirator is a device for administering artificial respiration in cases of diaphragmatic or intercostal paralysis. The Council on Physical Medicine and Rehabilitation voted to include the portable respirator in its list of accepted devices.

Sonotone Professional Table Set Model 50 Hearing Aid. — This hearing aid is designed to be placed on a desk at which the physician and patient are seated so that the physician may converse with the patient. The Council on Physical Medicine and Rehabilitation voted to include this table set model in its list of accepted devices.

John Augustus Toomey

Dr. John Augustus Toomey, internationally famous for his studies on poliomyelitis, died Jan. 1, 1950, of cerebral hemorrhage. Dr. Toomey was born in Cleveland, May 25, 1889, and before beginning the study of medicine completed the study of law. He later entered the Western Reserve University School of Medicine, obtaining the doctor of medicine degree in 1919. Subsequently he became professor of clinical pediatrics and contagious diseases at his alma mater. In 1940-1941 he was vice-chairman of the Section on Pediatrics of the American Medical Association, and in 1947-1948 he was president of the American Academy of Pediatrics. The breadth of his professional interests is indicated by the number of learned societies in which he maintained membership: American Public Health Association, American Association for the Advancement of Science, American Pediatric Society, American Academy of Pediatrics, Society of American Bacteriologists, Society of Experimental Biology and Medicine and the American Congress of Physical Medicine. He was a fellow of the American College of Physicians and a specialist certified by the American Board of Pediatrics. Dr. Toomey was physician in charge of the division of contagious diseases of the Cleveland City Hospital and associate pediatrist of the University Hospitals.

John E. Lovelock

With sorrow we report the passing of Dr. John E. Lovelock, who was killed in a subway accident Dec. 28, 1949, in New York City. Dr. Lovelock was assistant director of physical medicine and rehabilitation at The Hospital for Special Surgery in New York City. He was vitally interested in our work and had contributed articles on athletic injuries, physical fitness and rehabilitation.

Dr. Lovelock was born in New Zealand on Jan. 5, 1910. He was a Rhodes scholar at Oxford in 1931 and took his medical degree at Oxford University in 1937. He was a major in the British Army during the war in charge of rehabilitation in the British Army. He was also on the medical executive committee of the Fourteenth Olympic Games in London in 1947. However, it was in athletics that he attained a worldwide reputation. He represented Great Britain in the Olympic Games at Los Angeles. He beat our best milers in the early 1930's. He made the world's record in the 1,500 meters and won the same distance in the Olympic Games in Berlin, 1936, in a record time which still stands today.

Dr. Lovelock leaves behind a memory, not only of a great sportsman but of a pleasing personality who was loved by every one who came in contact with him. He played the game of life in the great tradition of the game of sports.

Alvin W. Foss

It is with regret that we announce the death of Dr. Alvin W. Foss of Rockland, Maine. Dr. Foss has been a member of the Congress for many years.

BOOK REVIEWS

NEUROLOGY. By *Roy R. Grinker*, M.D., Director of the Institute for Psychosomatic and Psychiatric Research and Training and Chairman, The Department of Neuropsychiatry of Michael Reese Hospital, Chicago, Illinois, and *Paul C. Bucy*, M.D., Professor of Neurology and Neurological Surgery, University of Illinois College of Medicine, Chicago, Illinois. Fourth Edition. Cloth. Price, $12.50. Pp. 1138, with 393 illustrations and 34 tables. Charles C Thomas, Bannerstone House, 301-327 East Lawrence Ave., Springfield, Illinois, 1949.

While neither Grinker nor Bucy need an introduction for both are outstanding and well known specialists in their field, they are to be congratulated for presentation of the most outstanding volume on Neurology. The book is also a great credit to the publisher. The book is well illustrated and with excellent reproductions. The type used is easy to read. The subject matter is very concise and simple readable language is used throughout. Neurology is a tremendous topic and one is astonished that the authors have been able to cover the subject so well and so fully within the confines of one volume. This should make an excellent reference work for medical students, neurologists, general practioners and certainly every physiatrist and physical therapist should have this work.

The first chapter deals with the neurological examination. Chapter 2 is devoted to a discussion of the spinal roots and nerves. It is a little disappointing to find that the authors only include Erb's R. D. test and chronaxie for electrodiagnosis. While R. D. is a rough qualitative test, it is rapidly being replaced by the use of current impulses of definite duration, interval and intensity. The fallacy of the chronaxie measurements have been fully pointed out by Pollock. At no time do the authors discuss the place of electromyograms in the diagnosis of peripheral nerve lesions. The reviewer feels that a discussion of these newer tools would have added to the value of the splendid volume. Another disappointment is the place given to electrical stimulation of muscle. In recent years research groups have never used electrical current to hasten nerve regeneration as stated by these authors. It has been used, however, to maintain the muscle as a contractile organ with a minimum loss of weight and strength loss until the muscle is able voluntarily to regain its function. Work has been done to show that under proper controlled conditions massage cannot take the place of electrical stimulation. Again the treatment from the standpoint of modern physical medicine is very inadequately dealt with. In the treatment of alcoholic neuropathy among other measures, the writers state that "gentle massage, gradually increasing, and passive motion judiciously applied are necessary to maintain muscle tone." Massage and passive motion cannot and do not maintain muscle tone.

Chapter 3 discusses tumors of the peripheral nervous system and spinal cord. The vegetative nervous system is discussed in chapter 4. In this section as well as in other appropriate sections the electroencephalograph is given its place in diagnosis. This is well presented with many excellent patient records. The reviewer is not in accord with the use of the electrothermocouple for skin temperature measurements as advocated by them to determine the feasibility of doing a ramisectomy for vasospastic conditions. In the treatment of vasomotor-trophic diseases one wonders what is meant by the faradic brush and what is the timing to be used for the contrast baths.

Chapter 5 deals with the brain stem and the cranial nerves and chapter 6 with the pyramidal and extrapyramidal tracts. A chapter is given to each of the following subjects: intracranial tumors, the cerebrospinal vascular system, inflammatory and infectious diseases of the nervous system, degenerative diseases, developmental defects, syphilis of the nervous system, trauma of the central nervous system, the epilepsies, exogenous toxins and noxious agents affecting the nervous system, the myopathies and headaches. The volume closes with an extensive bibliography.

This volume is an outstanding work and is highly recommended to the physiatrist and physical therapist.

COMPONENTS HANDBOOK. Edited by *John F. Blackburn*, Massachusetts Institute of Technology. Volume 17 in the Massachusetts Institute of Technology Radiation Laboratory Series. Cloth. Price, $8.00. Pp. 626 with 368 illustrations. McGraw-Hill Publishing Company, 330 West 42nd Street, New York 18, N. Y., 1949.

During the recent war the radiation laboratory at the Massachusetts Institute of Technology did the major work in the development of radar and associated systems. The tremendous amount of work done in this laboratory is being published by the McGraw-Hill Publishing Company as the Radiation Laboratory Series of which the present book is Volume number 17.

This book is a description of the different types of electronic components available, and as such its usefulness goes far beyond the field for which it was originally developed. Anybody familiar with developing of new equipment in Physical Medicine and physiology for which electronic components are needed will have, at one time or another, expressed a desire for a book just like this. This book is not a catalogue of available equipment. Rather it is a description of what a good

electronic part should be and what some of the difficulties are that electronic equipment in itself may offer.

With this book it is possible to make an intelligent decision as to what electronic equipment to use and for what purpose. It discusses such questions as how much one load one can put in of certain component parts and for what functions they can be used.

Due to the termination of the grant under which these books are written, it has, unfortunately, been necessary to omit a few chapters which were planned. But the omissions do not appear serious.

For anybody who plans to design electromedical equipment or familiarize himself with the details of the functioning of electrophysiologic or electromedical equipment this book is an absolute essential.

DOCTOR AND PATIENT AND THE LAW. By *Louis J. Regan*, M.D., LL.B., Member State Bar of California; Professor of Legal Medicine, College of Medical Evangelists; Consulting Staff, Hollywood Presbyterian Hospital, L. A.; Methodist Hospital of Southern California, L. A.; Physicians and Surgeons Hospital, Glendale, California. Second Edition. Cloth. Price, $10.00. Pp. 545. The C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, Mo., 1949.

So busy are most physicians with the scientific practice of medicine that they have little time or inclination to keep abreast of changes in the general laws under which they are privileged to practice. It comes as something of a shock to them to learn that the law, like medicine, changes with the years. When they are confronted with accusations, threats, suits—usually groundless but nonetheless disturbing—they are at a loss how to proceed. Even though their logical action is to consult their attorney, their mental agitation and the disturbance of their professional balance would be lessened if they had an up to the minute knowledge of their own rights, privileges and obligations.

That is where the work of Louis J. Regan, "Doctor and Patient and the Law" makes its special appeal and the appearance of a second edition of this comprehensive volume should not pass unnoted by doctors. The book is of particular value in this locality in that its author is not alone a physician but also an attorney, licensed to practice both professions in California, which is his home. However, he confines his exposition to no one state but takes in the decisions and opinions — often conflicting — which arise in different sections.

The legal provisions, legal duties and obligations acquired and assumed with the license to practice medicine, the relationship with patients (both legal and ethical) are clearly set forth by the author with citations of numerous decisions and with specific legal "case histories."

While a full discussion of the subject of malpractice continues to occupy a large section of the second edition, it is far from constituting the bulk of the valuable volume. Dr. Regan, stressing the prevention of legal action by fore knowledge of legal requirements, has enlarged or covered a number of new topics in this second edition; topics to which the changing times have imparted a particularly important impact. Among them, such matters as Adoption, Artificial Insemination, Blood Grouping Tests in Affiliation Proceedings, Contracts in Restraint of Trade, Coroners and Medical Examiners, Disclosures Under Statutes, Dying Declarations, Essentials of a Constructive Malpractice Prevention Program, Federal Food, Drug and Cosmetic Act, Insane Persons.

There are a vastly varying number of questions aroused by those and many other sections in Dr. Regan's book, which must come up in any medical practice, general and specialist, that will find answer. For instance, how many doctors know that the troublesome legal doctrine of *res ipsa loquitur* ("the thing speaks for itself") carrying the inference of negligence is interpreted differently in such a matter as x-ray burns, courts holding that it is applicable when the x-ray is used diagnostically, but dividing upon whether it applies with therapeutic use of the x-ray.

Another subject often neglected on which Dr. Regan writes illuminatingly, is the responsibility of the patient himself in following directions. Many are the quirks of legal medicine which the author incorporates, such, to cite but a few, as how much, in the absence of express agreement, a doctor may charge a patient and under what circumstances a third party may be liable for fee; his rights in respect to practice in a hospital and how much he is liable for acts of hospital personnel; the value and limitations of "Standing Orders" for nurses in industry; and care as to making statements which may be construed as an admission of negligence.

The reviewer of this second edition was privileged to review Dr. Regan's first edition; and, as I stated in that review, I repeat now—that it is beyond my comprehension how any physician in any branch of medicine can afford not to have a copy of this work, not only in his library, but on his desk within easy reach for ready reference. I have reviewed many books on medical-legal subjects and consider Dr. Regan's "Doctor and Patient and the Law" as not only one of the best, but the best book in this field.

OBESITY. By *Edward H. Rynearson*, M.D., F.A.C.P., Division of Medicine, Mayo Clnic, Associate Professor of Medicine, Mayo Foundation and *Clifford F. Gastineau*, M.D., Fellow in Medicine, Mayo Foundation, Rochester, Minnesota. Fabrikoid. Price, $3.50. Pp. 134. Charles C Thomas, Publishers, 301 East Lawrence Avenue, Springfield, Ill., 1949.

Consolation will be meager for the individuals, including the obese physician, who attempt to justify the excess weight on forces other than the large influx of food. Approximately one-half of the book is on the etiology of obesity in which the various factors usually suggested as the cause are considered. The reports from various investigators about the endocrines as possibilities are cited and these are countered by equally good references plus the convincing opinions and rationale of the authors. The hereditary predisposition, the

"big frame" and constitutional abnormalities (diseases such as progressive lypodystrophy, adiposis dolorosa and lipophilia) which are also used as arguments for overweight, prove to be poor evidence as shown by their interpretation. And even the high sounding physiologic mechanisms such as retention of water, ketosis, respiratory quotient, reduced specific dynamic action and others are shown to be mere "vagaries" when well controlled studies have been done. All of this should be known and should be familiar knowledge to physicians but in observing the size of most Americans, this monograph is certainly necessary to refresh their memories.

The chapter on diet is contributed by Miss Alice Karslake Irmisch, the dietitian at the Mayo Clinic in which many practical suggestions are given including samples of low caloric diets, psychologic aids, the food nomogram, consideration of vitamins and minerals, tables giving food values and others. A complete and up to date bibliography is appended. Much material is packed into this small book which is clearly and pleasantly presented. It is a worthy addition to the American Lecture Series that are being published.

MEDICINE OF THE YEAR, 1949. Edited by *John B. Youmans*, M.D., Dean, College of Medicine, University of Illinois. Cloth. Pp. 143. Price, $5.00. J. B. Lippincott Company, East Washington Sq., Philadelphia 5, Pa., 1949.

This summary of recent medical progress covers the subjects of Internal Medicine, Allergy, Anesthesia, Cardiovascular Diseases, Dermatology, Endocrinology, Fractures, Gynecology, Neurology, Neurosurgery, Obstetrics, Ophthalmology, Orthopedics, Otolaryngology, Pediatrics, Psychiatry, Pulmonary Diseases, Surgery and Urology. The reviews are uniformly of high quality and authoritative, as every contributor is a leader in his field. Selected references are appended to each chapter. General practitioners and medical students should find this a useful reference. Physical Medicine and Rehabilitation are not discussed.

THE NEUROANATOMIC BASIS OF SURGERY OF THE AUTONOMIC NERVOUS SYSTEM. By *Albert Kuntz*, Ph.D., M.D., Professor of Anatomy, St. Louis University School of Medicine, St. Louis, Missouri. Price, Paper $1.65; Lexide, $2.25. Pp. 83 with illustrations. Charles C Thomas, 301-327 East Lawrence Avenue, Springfield, Ill., 1949.

This is another of those excellent monographs of the American lecture series published by Charles C Thomas. The author of this well prepared monograph certainly is a guarantee of its merits. Dr. Kuntz has written a most instructive and valuable guide in this important field of surgery.

The subject matter is divided essentially into two main sections. The first thirty-six pages deal fully and admirably with the anatomy of the autonomic nervous system. The author has presented this difficult phase of the subject concisely but fully. All irrelevant material is missing. The illustrations are clear and well executed and easily followed. The author classifies the autonomic nervous system both from the anatomic and physiologic viewpoint.

The section dealing with surgery is just as ably dealt with. The pitfalls to be guarded against for successful results are stressed. Anyone interested at all in this popular branch of surgery will do well to read this small but succulent monograph. The book is small enough to place in the coat pocket with ease. The text is well written and easy to read. This monograph is highly recommended to all physicians, physiatrists and physical therapists.

PHYSICS AND THE SURGEON. By *H. S. Souttar*, D.M., M.Ch. (Oxon.), F.R.C.S. (Eng.), Hon. M.D., Trinity College, Dublin; Hon. F.R.A.C.S., Consulting Surgeon, London Hospital. Pub. No. 48, American Lecture Series. A Monograph in American Lectures in Surgery. Edited by Michael E. DeBakey, M.D., Professor Surgery, Baylor College of Medicine, Houston, Texas, and R. Glen Spurling, M.D., Clinical Professor of Surgery, University of Louisville, Louisville, Kentucky. Lexide. Price, $2.00. Pp. 60, with 41 illustratoins. Charles C Thomas, 301-327 East Lawrence Avenue, Springfield, Illinois, 1948.

This small monograph is divided into two parts. Part one deals with general physics and part two with atomic physics. It is hardly to be expected that one can condense physics into forty-one pages. The author barely states the nature of the problems met by the surgeon, and how to remedy some of the most common difficulties encountered. The reviewer feels that part one is too elementary to be of much practical value. This is especially true of the section devoted to electrotherapy.

For those who wish to get information on atomic physics the monograph is extremely valuable. It is not written for a physicist but for the busy practitioner. Mathematics is entirely eliminated and the text is written in simple understandable language. The author carefully steers the reader through the intricacies of the Rutherford atom, isotopes, radiation, radiation of the atom and radioactivity by easy steps and consummate skill. This is a book the novice will enjoy to gain an insight into the newer tools of medicine and surgery. Anyone interested in atomic energy will find this an interesting treatise.

REHABILITATION OF THE HANDICAPPED. A Survey of Means and Methods. Edited by *William R. Soden*, Executive Assistant, Physical Medicine Rehabilitation Service, Veterans Administration Hospital, Northampton, Massachusetts, with a Foreword by *Sidney Licht*, M.D., Editor, "Occupational Therapy and Rehabilitation." Cloth. Price, $5.00. Pp. 399. The Ronald Press Company, 15 East 26th Street, New York 10, N. Y., 1949.

The ever broadening scope of rehabilitation makes it almost impossible for any one individual to have acquired by this time a sufficient practical

knowledge of its many aspects. Hence, the justification for the succession of volumes consisting of papers or original articles collected from various authors. The present volume appears to be the most comprehensive so far, as to its conception of the range of the subjects covered as well as to competence and ability of contributors. The five main parts are: General Medical and Surgical Technics, Neurological Methods, Psychiatric Developments, Vocational and Social Rehabilitation, Educational and Psychological Trends. The topics covered range besides the strictly medical subjects, from Alcoholics Anonymous to Vocational Rehabilitation and Volunteer Workers. The total number of contributors is 38, about one-third of the articles are republications. There is a fitting foreword by Sidney Licht, M.D., and among the better known authors in this survey are Drs. Walter M. Solomon, Alexander P. Aitken, Richard Kovács, A. Ray Dawson, A. B. C. Knudson, Henry H. Kessler, Winthrop M. Phelps, William G. Lennox, Charles C. Burlingame, Augustus Thorndike, James S. Greene, and Earl C. Elkins. This volume will offer stimulating and informative reading to everyone interested in the vast aspects of modern rehabilitation.

THE SUPERSENSITIVITY OF DENERVATED STRUCTURES. By *Walter B. Cannon*, late George Higginson Professor of Physiology, Emeritus, Harvard University, Boston, Massachusetts, and *Arturo Rosenblueth*, Head of the Department of Physiology and Pharmacology, Instituto Naconal de Cardiologia de Mexico, Mexico City. Cloth. Price, $5.50. Pp. 245 with 62 illustrations. The Macmillan Company, 60 Fifth Ave., New York 11, N. Y., 1949.

This most unusual book by the late Professor of Physiology at Harvard University and his close associate covers a physiologic principle which is traced through different special physiologic fields. The book treats of the supersentivity which occurs in an excitable tissue once this tissue has lost its innervation. Evidence is given from many fields in physiology that this is a general physiologic concept starting from two physiologic phenomena which have been familiar to physiologists for a long time, namely, the paradoxical pupiliary dilation and the Vulpian phenomena.

Cannon and Rosenblueth have examined the supersensitivity occurring in smooth muscle both in excitation and inhibition, the supersensitivity of the melanophores in glands, the heart, in striated muscle, in sympathetic ganglia and in spinal neurons and coordinating centers. While to most specialists in physical medicine the supersensitivity of striated muscle is of most immediate importance, the very fact that we are dealing with a general physiologic phenomena is probably the most significant contribution that this study has made.

The last chapters of the book deal with the theories and implications of this sensitivation.

This scientific monograph is obviously not a textbook. It is a carefully documented experimental study of an important physiologic phenomena. It can be highly recommended to those who are interested in the problems of denervated muscle and in the basic physiologic concepts on which our treatment and electrodiagnosis of denervated muscle is based.

COLLATERAL CIRCULATION (ANATOMICAL ASPECTS). By *Daniel P. Quiring*, Ph.D., Head of the Anatomy Division, Cleveland Clinic Foundation and Associate Professor of Biology, Western Reserve University. Cloth. Price, $5.00. Pp. 142, with 61 illustrations. Lea & Febiger, 600 S. Washington Sq., Philadelphia 6, Pa., 1949.

This monograph was prepared to present a comprehensive picture of the practical anatomic aspects of problems in circulation as related to the development of collateral channels. The monograph is profusely illustrated with clear, well-labeled diagrammatic drawings which illustrate the various collateral channels as they are demonstrated in normal anatomy and as they become important functioning vessels after various types of occlusion or ligature. Significant bibliographic material is presented throughout the discussion. In addition to this, the actual anatomic studies of the authors are presented in a clear, concise and practical manner. The development of both arterial and venous peripheral collateral circulation is considered in great detail. There is a section devoted to a discussion of the coronary circulation and the anastomoses that can develop in the myocardium. The venous and arterial collateral routes that may be developed in the abdomen, thorax and trunk are described.

This monograph will be particularly interesting and valuable to the medical student while he is studying anatomy. It will prove to be a valuable reference work for the physician in general medicine or surgery or the specialist who has to deal with vascular or circulatory problems.

CLINICAL NEUROLOGY. By *Bernard J. Alpers*, M.D., Sc.D. (Med.), Professor of Neurology, Jefferson Medical College, Philadelphia; Neurologist to the Jefferson, Pennsylvania, and Wills Hospitals, Philadelphia. Second edition. Pp. 846, with 240 illustrations. Price: $9.50. Cloth. F. A. Davis Company, 1914-16 Cherry St., Philadelphia 3, 1949.

This text is intended for the use of students and general practitioners and admirably fits their needs. The subjects of neuroanatomy and physiology and pathology, which represent the essential background for neurological diagnosis, are described not in separate chapters but in relation to the clinical examination wherever possible. This method of presentation should capture the interest of the student and increase the usefulness for the general practitioner. The various disorders are taken up in an orderly fashion according to the portion of the nervous system affected. Numerous outlines, diagrams and photographs of good quality enhance the value of the book for teaching purposes. The printing is excellent and the paper and binding of good grade. The subject matter is up to date so that many years of usefulness can be anticipated. For the specialist there is not enough reference to original sources to attract but for its intended reader, primarily the student, it is highly recommended.

PHYSICAL MEDICINE ABSTRACTS

Physical Medicine in Peripheral Vascular Diseases. William Bierman.

J. A. M. A. **141**:318 (Oct.) 1949.

In a recent book on the diagnosis and treatment of peripheral vascular diseases, an outline classification of diseases and abnormalities of the blood and lymph vessels of the extremities occupies seven and one-half pages. From the point of view of prevalence, by far the great majority of these can be grouped under the headings, "Arteriosclerosis Obliterans," "Thrombo-angiitis obliterans," "Raynaud's Syndrome," "Varicose Veins" and "Thrombophlebitis."

All measures to relieve the subject with peripheral vascular diseases are intended to restore the normal balance between metabolic needs and supply of the tissues. A simple measure to increase circulation, when this is possible, is the use of heat. As with heat, exercise can increase both the circulation and the metabolic needs. Sanders devised an apparatus which automatically and continuously rocks the bed through an arc of 60 degrees at a slow regular rate. Histamine and acetyl-beta-methylcholine chloride applied by ion transfer will cause cutaneous vasodilatation and can therefore be employed for the treatment of peripheral vascular diseases.

Mechanical apparatus designed to produce an increase in peripheral circulation, such as that for alternating negative and positive pressures and for intermittent venous occlusion, are now but little used.

Clinically, the whirlpool bath has shown itself to be of value, even though objective evidence of increased circulation has not been observed following its application.

It has been observed that the application of cold causes a reduction in the temperature not only of the skin but also of the deeper structures. It has also been noted that cold applied to one area of the body (as to the forearm) produces a lowering of temperatures in remote regions (as the skin of the foot). The practical application of this objective evidence is to emphasize that those who are required to work in low temperatures should be warmly clothed all over.

Physical measures play an important part both in the diagnosis and in the treatment of peripheral vascular diseases. In a large percentage of cases relatively simple procedures, such as those commonly employed in clinical inspection and palpation, prove adequate for diagnosis and uncomplicated devices, such as hot water baths, heating pads, electric blankets, lamps, whirlpool baths, exercise and hygienic measures, are adequate for treatment purposes. Some persons who have peripheral vascular disease require the special disciplines which have been developed for the diagnosis and treatment of this condition. These measures may be of service for the prophylactic care and for the comfort of the elderly person and for the subject who shows subclinical signs of inadequate peripheral circulation.

The Painful Foot Following Injury. Emil D. W. Hauser.

Indust. Med. & Surg. **18**:326 (August) 1949.

The foot is the organ of locomotion and its function consists of weight bearing and propulsion. Pain interferes with this function and causes disability. Injuries to the foot that cause anatomical changes receive the careful attention of the surgeon. A weak foot results unless correct normal position is obtained with a corrective shoe and correct gait is instigated before the patient is dismissed.

Multiple Sclerosis. Tracy J. Putnam.

Crip. Child **27**:7 (June) 1949.

Irrespective of the cause of multiple sclerosis, many victims of it can be made more comfortable by attention to their symptoms. Of these, the ones which most commonly require treatment are spastic weakness, staggering and tremor of the hands. Until a decade or two ago, prolonged rest in bed usually was prescribed for patients suffering from multiple sclerosis and this treatment is still widely employed. It has been my experience over many years that confinement to bed, except in the most acute phases of the disease, tends to produce invalidism and incapacity, and to prolong the disability. Vigorous physical therapy, on the other hand, often greatly improves the patient's strength, functional ability and well being. The type and technic of physical therapy to be used in each case depends on the precise symptoms and the experience and ingenuity of the physical therapist. In general, it should be remembered that the weakness is spastic in origin; that is, that the muscles are out of control rather than partially disconnected from the nervous system, as in poliomyelitis, and that certain groups of muscles have become relatively more powerful than their opponents, because of the overactive reflexes. To restore the balance of muscular power, it is important first to determine which groups of muscles are weakest and to devise special exercises to develop them, while relaxing the groups which tend to go into spasm. The exercise should be vigorous and exerted against the greatest resistance that the muscles can overcome. When one group of muscles is fatigued, the process should

be repeated with another, and so on in rotation, until it is clear that the patient can do no more. Sometimes movements which seem beyond the reach of volition can be produced by having the patient will to make the movement, then eliciting a reflex which brings it about. After persistent practice in this manner, the movement may be made voluntarily. The application of heat and the use of relaxing drugs such as curare and Tolserol often aids in overcoming spasm. If movement of joints is limited, their range of motion often can be increased by manipulation. Electrical stimulation of weakened muscles is of questionable value, but may be worth trying. Tremor and staggering often may be overcome, at least partially, by exercises in coordination. The patient who is unsteady on his feet is taught to place them accurately in footsteps stencilled on the floor, and so gradually reacquires his balance and rhythm of walking. The patient whose arms are ataxic practices touching one spot after another until his aim improves.

Axon Branching in Nerve Regeneration and Its Trophic Effect on Muscle. Robert W. Thomas, and Harold A. Davenport.

Quart. Bull. Northwestern Univ. Med. School **23**:170 (Summer) 1949.

The ingrowth of nerve fibers from the cut end of the external aural into the distal stump of the common peroneal nerve, in the rat, was characterized by abundant bifurcation. After intervals of four to 24 weeks for recovery, the average number of fibers in the regenerated peroneal nerve was about three times as many as the number in the external sural, which was the sole source for regenerating axons. Regeneration from the proximal stump of the common peroneal was effectively prevented by Edds method of capping with methacrylate. The trophic support of peroneal muscles by motor fibers from the external sural was good, in that the weights of the muscles after 12 to 24 weeks for recovery was at least equal to, or somewhat greater than, the weight of muscle originally supplied by this nerve. Recovery weights of peroneal muscles were 50-70 per cent of normal weights, obtained by using the opposite side for controls. Considering the small number of motor fibers available for reinnervation, this seems to be evidence in favor of the physiologic effectiveness of axons branching during regeneration.

Athetoids Relax and Speak. Caro C. Hatcher.

Crip. Child. **27**:14 (June) 1949.

Speech training for athetoids is one of the most challenging fields in speech therapy. Alert as these cerebral palsied persons are, observations on their part have given them a feeling of pattern and a knowledge of speech production long before they arrive at their training period. However, they are defeated in actual speech by a voluntary tension that has become habitually a part of their conduct. We are confronted, therefore, with the major problem of dealing with this voluntary tension which is controlled only by relaxation and in diverting attention away from performance. Actual therapy does not have to be an initial part of the program; in fact, it is not necessary for some time. I feel that it should be postponed until adequate personal relationships are established and a total picture of the problem is obtained. Speech therapy per se is not likely to be needed with the average athetoid. The speech therapist needs to be able to deal with such problems as overprotection, non-acceptance, lack of security, improvised communication systems, etc., rather than teach proper lip and tongue movement or other mechanism performance. Improvement in physical development is of great importance. This includes the development of the use of the limbs, particularly the hands, inducing proper breathing and encouraging chewing, sucking, and swallowing movements. An integrated program of speech therapy, physical therapy, and occupational therapy appears almost adamant in any speech rehabilitation program for the athetoid.

Peripheral Nerve Injuries from Administration of Penicillin: Report of Four Clinical Cases. Thomas Ray Broadbent; Guy L. Odom, and Barnes Woodhall.

J. A. M. A. **140**:1008 (July 23) 1949.

This report describes the clinical course of 4 patients in whom there developed a peripheral nerve lesion immediately following the administration of penicillin into or about a peripheral nerve. This penicillin-induced lesion was characterized by the rapid onset of severe tingling pain of short duration, a pronounced and only slowly improving motor disability and a moderate inactivation of sensory axones. Four cases of injury to a major peripheral nerve by penicillin injections are reported. In view of the established toxicity of this antibiotic in other parts of the nervous system, it is assumed that this neuritis represents a specific reaction to a high concentration of penicillin.

Rehabilitation in Poliomyelitis. Kristian G. Hansson.

New York State J. Med. **49**:923 (April 15) 1949.

During the last eight years there has been much discussion on the early treatment of poliomyelitis, the percentage of recovery, and the mode of early treatment. In studying the various reports the end results were very much the same with the different treatments, i. e., 70 per cent recovered completely, 18 per cent showed slight residual paralysis, and 12 per cent severe paralysis. It is this last group of patients with marked handicaps where rehabilitation plays an important part. The rehabilitation in polio really starts in the acute stage in the form of prevention of deformity. Bed rest versus activity and nutritional requirement must be determined for each individual patient. Physical restoration to strengthen and coordinate muscles, to support joints by braces or orthopedic operations, and to retrain the pa-

tient in a new functional activity has received additional emphasis since the war. Mental readjustment should not be neglected in a disease that can strike the healthiest individual and make a wheelchair patient out of him in a very short time. Vocational training is the responsibility of the community, the State, and the Federal government and is also recommended to make the handicapped patient independent and a useful citizen. It is a duty to rehabilitate the polio patient after the acute illness. There are not enough hospitals equipped for this work. Special hospitals are needed for convalescent polio patients, especially for adolescent and adult patients. The polio patients in New York are well cared for, thanks to the support of the National Foundation for Infantile Paralysis. It is only to be hoped that New York will soon have adequate convalescent hospitals for all polio patients, including adults.

Antibiotics and the Prevention of Postoperative Pulmonary Complications. Stanley O. Hoerr.

Ohio State M. J. **45**:225 (Mar.) 1949.

This paper reports a follow-up study of one hundred private psychotic patients treated with electro-coma therapy in 1941-1942. The immediate and early results of electro-coma therapy were uniformly good in a high percentage of cases. Eighteen patients, chiefly schizophrenics and some with involutional melancholia, did not progress to full recovery or relapse soon after the initial improvement. Some were quite well for a period of months or several years and then later developed regression. This group is considered as failures. However, many of these failures represent chronic patients who were treated with a full realization of the doubtful outcome only at the request of an insistent family. Several chronic schizophrenics have improved with electro-coma therapy and have maintained apparently normal health over a period of seven years. Eighteen patients showed partial improvement. They have maintained a fairly satisfactory social and industrial status. Sixty patients showed a successful response to electro-coma therapy. Thirty-eight of this group have maintained well-being for the entire period of six to seven years. Twenty-two improved, then developed recurrences at a later date which fortunately cleared up with additional courses of treatment. The successful cases consisted largely of depressed patients and several manics. However, there were several schizophrenics among them. There were no instances of epilepsy or death as a complication of electro-coma therapy. In the large group of patients who were closely followed over a period of years, we have not encountered any instances of mental deterioration. Indeed, the sixty patients who are grouped as successfully treated consist of men and women in all walks of life who are maintaining or advancing in their jobs, careers, and in their social living. The present technic is considerably improved over that which we employed in 1941 and 1942. The improvements consist of pretreatment medication, smaller doses of electricity, and particularly ambulatory electro-coma therapy. An extensive experience during the recent three years as well as in 1941 and 1942 heartily endorses the value of ambulatory electro-coma therapy. We stress the importance of a sincere psychiatrist, trained in electro-coma therapy, rather than the need of hospital walls and hospital atmosphere in preventing abuses. The man is more significant than the masonry.

The Patient with Bulbar-Respiratory Poliomyelitis. Frederic J. Kottke, and William G. Kubicek.

Am. J. Nursing **49**:374 (June) 1949.

The polio patient with bulbar and respiratory paralysis presents a number of serious nursing problems. Bulbar involvement with paralysis of the muscles of the palate, pharynx, and larynx makes it difficult or impossible for the patient to maintain an open airway. Partial or complete obstruction of the airway through the nose, pharynx, larynx, and trachea results in hypoxia (insufficient oxygen), aspiration of mucus into the trachea and lung, and pulmonary edema. When mucus or saliva is aspirated atelectasis and pneumonia result. Paralysis of the respiratory muscles makes assistance in ventilation imperative, or the patient will suffocate. At the present time adequate assistance to respiration can be obtained only by placing the patient in a tank-type respirator which immobilizes him almost completely. This adds further hazards to survival. It is difficult to reach the patient. It is hard to treat him in any position except on his back. Prolonged immobilization on the back results in pulmonary congestion and pulmonary edema with a progressive decrease of useful lung volume. The forced inspiration of the respirator results in aspiration of material from the pharynx into the trachea and the lung. The nurse who is caring for a polio patient with bulbar-respiratory polio needs to be on the alert constantly for signs that the patient is not getting an adequate exchange of air. The earliest symptoms of inadequate ventilation or asphyxia usually are due to accumulation of small amounts of carbon dioxide. One of the first signs is an increase of the pulse rate. The pulse rate is a very sensitive index of asphyxia, and often precedes by a number of hours other important signs of asphyxia or hypoxia. Mild asphyxia also produces apprehension in the patient long before he has reached the stage where there is any cyanosis. A rise of body temperature may be a sign of a decrease of oxygen saturation in the blood. When the patient's temperature begins to rise, he should be examined carefully to see that it is not due to partial obstruction of the airway with an inadequate supply of oxygen. Cyanosis is a very late sign of inadequate oxygenation. When it occurs it means that the patient has already passed the danger level of hypoxia. Consequently, care of the patient should be such that cyanosis never develops.

Early Ambulation in Obstetric and Gynecologic Cases. R. de Soldenhoff.

Lancet 2:955 (Dec. 18) 1948.

According to de Soldenhoff there is considerable variation in what is meant by early ambulation. In the United States it means getting out of bed in the first twenty-four hours after operation or delivery. In some parts of Europe the patient walks back from the theatre or delivery room. To the author early ambulation means to be out of bed on the third postnatal or postoperative day, though occasionally he has followed Leithauser's technic of making the patient stand by the bedside and cough three or four times within eight hours of operation, particularly where pulmonary complications may be expected. The results of a year's trial of such early ambulation are here compared with those of a previous year in a survey of 2,735 admissions, with 1,878 deliveries. The author found that in cases of Caesarian section, myomectomy and other operations, the psychologic response of early rising is most pronounced, particularly in cases of repeat Caesarian section in women who previously had been fourteen days in bed. The patients appear to be impressed by their rapid return to normality. Early rising is particularly valuable after an abdominal operation, because the loss of muscular tone is more rapid and the interference with respiration more complete than in any other type of case, and recumbency reduces the vital capacity. The author is convinced that early ambulation does no immediate harm either to obstetric or to gynecologic patients, and it certainly allows a much bigger turnover of patients in hospital. It is hard on the staff, but a physical therapist saves the nurses much work by encouraging patients in their exercises.

Manipulation and Treatment of Pain in the Chest. John McM. Mennell.

New Zealand M. J. 47:586 (Dec.) 1948.

Unless manipulation is aimed at righting a definite demonstrable wrong then, as a method of treatment, it must fall into the category of "placebo" and justify the suspicion with which it seems to be regarded. Manipulation means the restoration of the natural function of a joint by induced normal movement in cases where impairment of movement is the direct cause of pain which may be local or distant. It is used in treatment to restore the normal range of movement in a joint functionally impaired. To stabilize on the one hand and mobilize on the other is an inviolable rule of technic. This should prevent further damage to the joint in question as well as to a joint in the neighborhood less affected or not affected at all.

Results will be disappointing if the supporting structures of the joints concerned are ignored in after-treatment. When these supporting structures, i. e., ligaments and muscles, are inadequate to prevent recurrent joint strain and consequent recurrent joint locking, support or fusion constitutes the most rational treatment.

Faulty posture in itself predisposes to interlaminar joint strain and pain, and it must not be forgotten that such posture may be aggravated by too rapid growth in adolescence, occupation, laziness, as well as by fatigue or disease.

Disease may produce its effect by increasing fatigue causing faulty posture or by actual joint changes.

In any illness of an infective nature or involving prolonged rest in bed, muscle and ligament changes occur with resultant impairment of joint function.

In conclusion, it must be remembered that if the success of manipulation depends on how it is done, it depends no less on why and when it is done. Empirical manipulation is doomed to failure.

Present Position of Radiotherapy in Medical Practice. B. W. Windeyer.

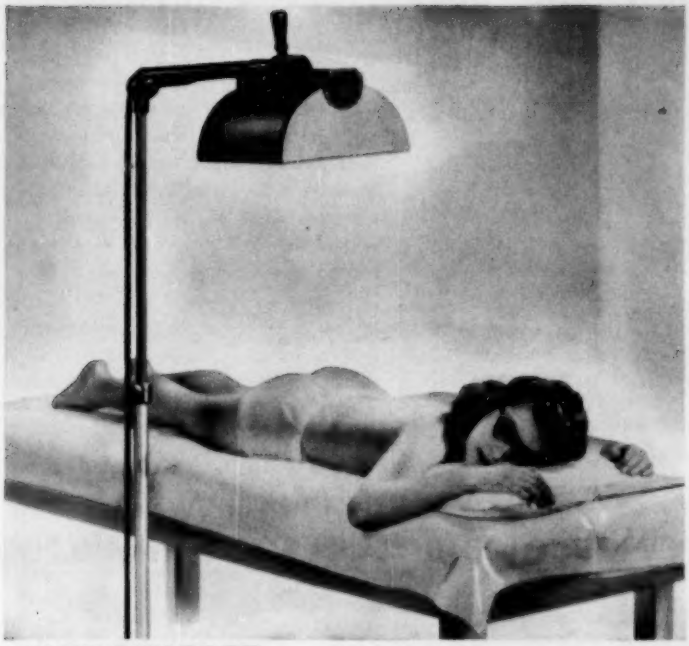
J. A. M. A. 140:665 (June 25) 1949.

The whole question of the control and use of radioactive isotopes is one of great importance. It is believed that their method of action on normal and pathologic tissues, the clinical reactions produced and, in particular, the dangers of severe and permanent damage which may occur from their use make it essential that they should be used by workers who are fully trained in the use of radiations on human tissues. It is obvious that the best results will be obtained, both with regard to rapid accumulation of knowledge and to efficient treatment of patients with the minimum risk, if the therapeutic use of radioactive isotopes is in future entrusted to radiotherapists.

Tonsillectomy During Epidemic Poliomyelitis.

J. A. M. A. 140:479 (June 4) 1949.

The Journal, March 21, 1942, warned that poliomyelitis, particularly the bulbar form, greatly increased in children after tonsillectomy or adenoidectomy in epidemic areas. Reports of Stillerman, Fischer, Maxwell, Marks, Top, Ayecock and Sabin were cited. Since that time avoidance of such operations during epidemics has been almost universally adopted. Recently, otolaryngologists seem inclined to the belief that a casual relationship does not exist between the two and that bulbar poliomyelitis following tonsillectomy is probably purely coincidental. The weight of past and recent evidence favors the existence of such a relationship. As tonsillectomy is an elective operation which rarely requires immediate surgical attention, the preventive attitude of delay is justified. Until conclusive evidence is presented that such procedures do not increase incidence of poliomyelitis the inadvisability of operating during periods of epidemic poliomyelitis should be emphasized.



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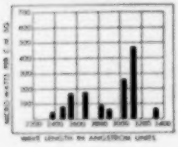

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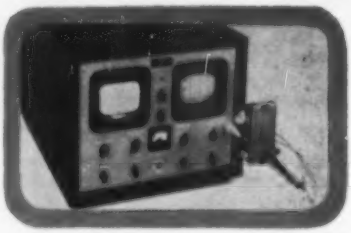

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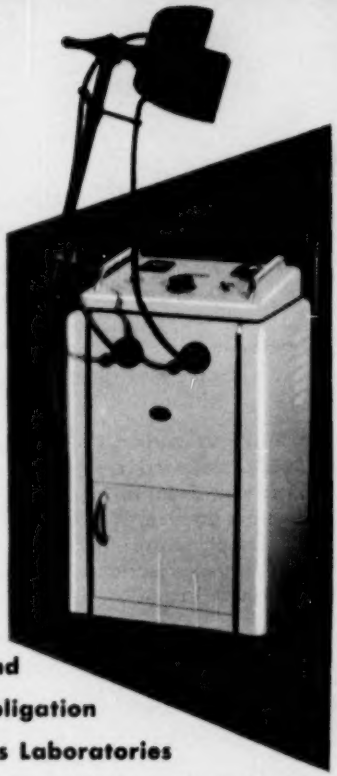

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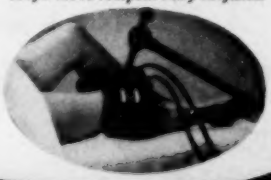
WRITE FOR FREE ILLUSTRATED BROCHURE ABOUT THE BANDMASTER AND THE NEW TRIPLE INDUCTION DRUM.

Notice the ease with which the new TRIPLE INDUCTION DRUM conforms to complex body surfaces.



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